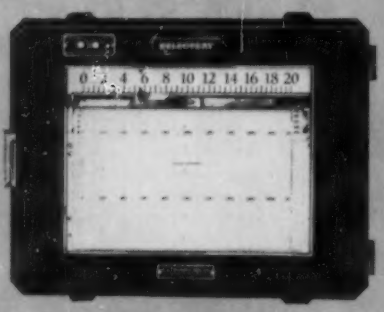
C. 1947
20 No. 12

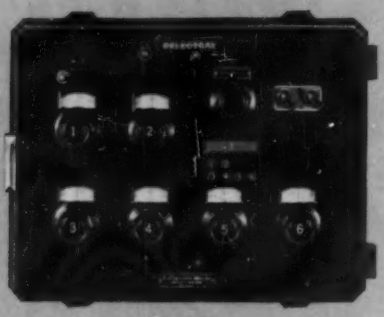
Instruments

E MAGAZINE of MEASUREMENT and CONTROL

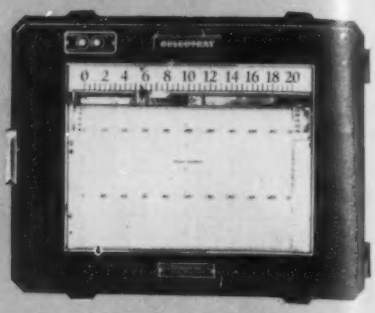
THERE IS A CELECTRAY FOR EVERY LABORATORY and INDUSTRIAL PYROMETER REQUIREMENT



CELECTRAY RECORDER CONTROLLER for Throttling Electric Heat

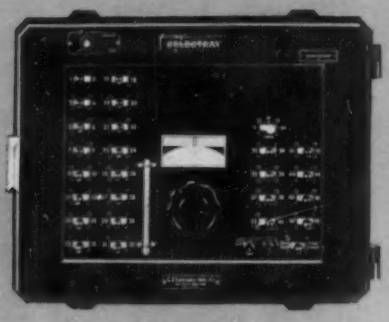


CELECTRAY 6-Point INDICATING CONTROLLER Also made for 3, 4 and 5 Points



CELECTRAY RECORDER CONTROLLER for Throttling Fuel Heat

CELECTRAY Single Point INDICATING POTENTIOMETER CONTROLLER



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The CELECTRAY principle of potentiometric measurement and control of temperatures has been reduced to practice in many laboratory and industrial applications. This is because the CELECTRAY Controller provides an economical means for throttling electric heat with no other equipment than is ordinarily used for on-and-off control.

This Controller has no dead zone and holds a steady temperature without oscillation. The TAG method of electrically balancing a potentiometer or Wheatstone bridge means higher recording accuracy which increases the value of CELECTRAY as a precise electrical instrument.

The CELECTRAY Pyrometers shown here include most of the models for indicating, recording and controlling. The most compelling feature of this notable line of pyrometers is expressed in terms of their contribution to more precise and economical plant operation.

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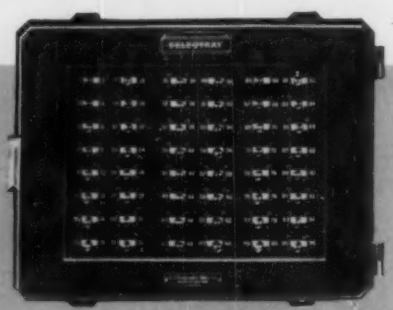

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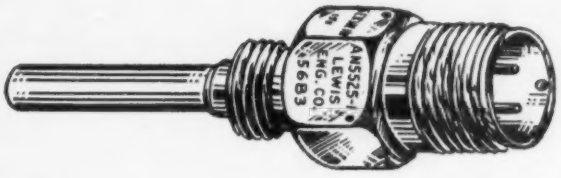

MODEL 56B3
(AN5525-1)

THE LEWIS RESISTANCE BULB MEETS EXACTING SPECIFICATIONS

✓ **RESPONSE TIME** — Averages 5 seconds from 100°C to 10°C when taken from boiling water to an ice bath.

✓ **HERMETICALLY SEALED** — Silver Soldered Assembly, by means of modern induction heating methods. The Terminal Pins are sealed in glass to the metal cap as in electronic tubes.

✓ **HIGH TEMPERATURE OPERATION** — Built to withstand a test temperature of 300°C for one minute. Bulbs model 56B5C and 56B6 will withstand operating temperatures of 500°F for a minimum of 500 hours. Model 56B6D will withstand 300°C for a minimum of 8 hours.

✓ **TOUGH** — Built to "take it" of Stainless Steel. The stem is of 18-8 type 304 (AMS5560A) and the head is constructed of Type 303 (AMS5640B). Polarizing Pin is of unique construction to prevent bending, twisting, or becoming loose.

✓ **STANDARDIZED RESISTANCE Vs. TEMPERATURE** — The resistance - Temperature characteristics meet "AN" specifications from —70°C to +200°C, and have been extended to 300°C.

✓ **ACCEPTED AS STANDARD BY LEADING AIRFRAME MANUFACTURERS** —

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PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

INSTRUMENTS ON THE MARCH

Ride Stabilizer Developed for Railroads and Busses

PITTSBURGH, Penna.—An "educated shock absorber" has been developed by Westinghouse research engineers to provide train and bus travelers the smoothest rides in land transportation history. The new stabilizer is designed to (1) eliminate more than 60% of the bumps and sway caused by irregularities in tracks or roads, (2) enable trains to take curves at more than 25% greater speeds, (3) bring about a four-fold over-all improvement in riding ease of trains and busses and (4) permit increased traffic over present rails and highways.

The stabilizer is the invention of Dr. Clinton R. Hanna, Stanley J. Mikina and Lawrence B. Lynn of the Westinghouse Research Laboratories. Railroad engineers also made significant contributions to the development. It is being road-tested by a railroad and application tests are being planned by a bus manufacturer.

Floating weights that feel up-and-down and sidewise motion, and a pendulum that senses the pull of centrifugal force and gravity, working together or separately, detect and respond to bumps or side-sway in 0.003 second. They anticipate the movement and correct it before it is felt by the train or bus passengers.

The stabilizer automatically moves the car tracks on bus wheels up and down to compensate for bumps in the road surface. Train wheels are moved from side to side to correct for track weaving. A tilter banks the car or bus body as it rounds a curve. As applied on a railroad car, this is done by six hydraulic cylinders and a pair of motor-driven screw-jacks. Four cylinders take care of vertical bumps and two side-sway.

When the car comes to a bump or dip in the track the floating weight instantly senses the motion of the body as it begins. The movement opens one valve and closes another, causing oil under high pressure to flow into the proper cylinder. The piston in the cylinder moves with just enough force in the right direction to counteract the bump and hold the car body virtually motionless. This takes place in 0.003 second. The same type of action moves the wheels right or left to correct for side-sway and the car body moves forward in a straight line. Flow of oil for the hydraulic system is maintained by motor-driven pumps.

When the train enters a curve, the gyro-controlled pendulum regulates two electrically-driven screw jacks placed at diagonal ends of the car body. If the speed is not quite right for the bank of the track, centrifugal force swings the pendulum. This closes an electrical contact to operate the two jacks which immediately tilt the car body to the correct bank angle.

The tilt mechanism can add up to 6° of additional bank in either direction within two seconds. So precise is its sense of balance that even when going around a curve at theoretical 40% overspeed, the tilter can bank the car within 1° of perfect equilibrium. The permissible speed on curves depends on the design of the locomotive, but even with this limitation the tilter will make possible 25% overspeed without passenger discomfort.

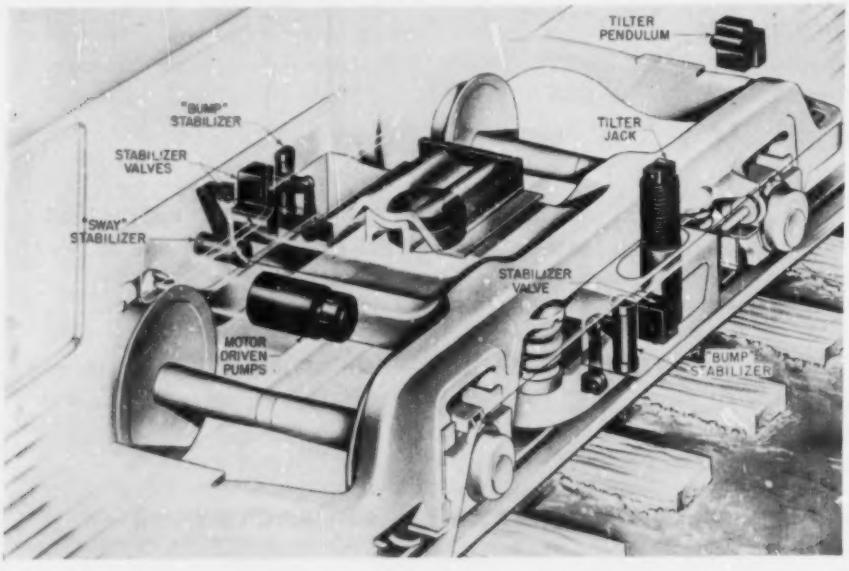
Going around a curve, even at high speed, the passengers will be able to stroll down the aisles without difficulty. When the train comes to a standstill on banked curves, the car body will be held perfectly level.

Although the best shock absorbers have been able to limit resonance to about 3", the stabilizer cuts it to less than 1"—an improvement of some 67%.

Passenger comfort is the chief aim of the stabilizer, but improved train and bus schedules should also result from its use since much higher speeds will be possible with comfort.

The same equipment used on railroad cars, modified slightly, can be applied to large passenger busses. For busses the system will be simpler, owing in part to the omission of lateral sway stabilizers, since busses have no swing link suspension.

Although the application of the new stabilizer to automobiles is more remote, parts of the new system have been used for some months on a large sedan owned by Westinghouse.



Phantom drawing showing how new Westinghouse stabilizer can be installed on a railroad car.
Screw jack or tilter jack (right) tilts car body to proper position as it enters a curve.
Two smaller bump stabilizers (on either side of truck) compensate for bumps or dips in track.
Sway stabilizer moves truck wheels from side to side while holding car body still to compensate for weaving.

Mine-detector Method Locates Screened-room "Grounds"

CHICAGO, Illinois.—Most manufacturers and many users of electronic equipment are familiar with the need for a screened room, free from radio signals and noises, in which to make certain electrical tests. The room consists of walls lined with two complete layers of copper screen or sheet. Those who have constructed screened rooms probably have discovered, upon completion, a fault or ground between the inner and outer screens. Standard procedure is to tear out the inner screen and rebuild it. One laboratory had to reconstruct the inner screen three times before it was ground-free.

Engineers at the Cook Research Laboratories recently had the familiar "grounding" experience but, before tearing out the screen, they decided to investigate the possibility of an electrical method of finding the faults. A tester was devised consisting of one standard laboratory oscilloscope, one solenoid exploring coil, and a 1-kva. 60-cps. step-down transformer.

The test method used, similar to land

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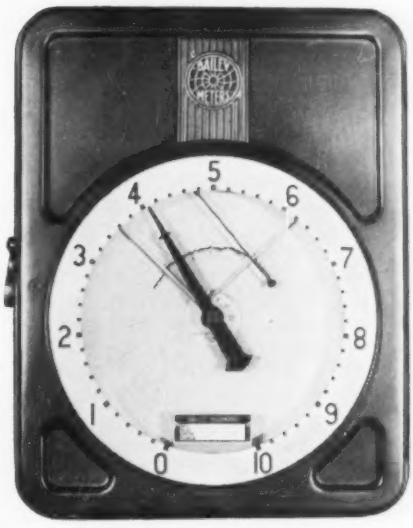

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This is typical of the advantages you get with Bailey instruments and controls. The 4-pen Pyrotron makes the same number of continuous records as four separate recorders. Each pen is actuated by a separate system. It draws a continuous record in a distinctive color. Package units are interchangeable. Our bulletin 230-A describes this space-saving unit in detail.

P-13

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mine detecting technique, was as follows: The low-voltage secondary of the transformer was connected with one terminal to the outer screen and one terminal to the inner screen. With its primary energized from the laboratory power circuit, approximately 100 amps. of 60-cycle current flowed from one screen to the other through the fault or faults. With this fault current flowing, the solenoid exploring coil (having its terminals connected to the vertical deflecting circuit of the oscilloscope) was moved along the inside wall of the room, and particularly along the wall-ceiling and wall-floor junctions.

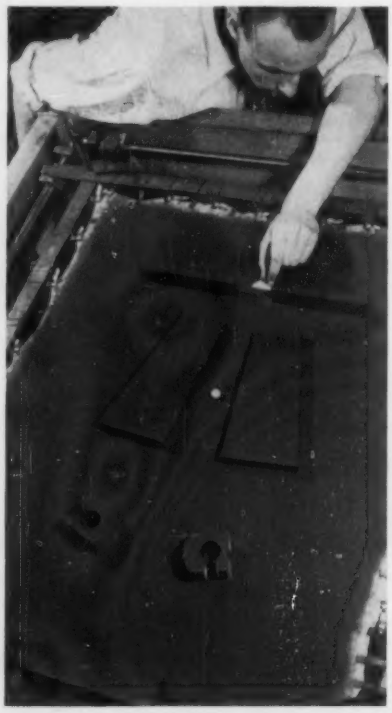
By observing the oscilloscope screen while moving the coil, the operator could observe the increase or decrease of signal produced by the magnetic field of the fault current flowing in the inner screen. As a fault was approached, the signal amplitude would build up and, when going directly over the fault, the amplitude would go to zero and reappear with *reversed* polarity. In every case, the faults were found to be at the exact points where the polarity-reversal took place. To prevent getting false indications of polarity reversal, the operator took care not to rotate the exploring coil about any of its own axes as he moved it along.

The method is obviously applicable to other similar fault-locating problems.

SPEEDS ANALYSES.—Mass production of luminescent materials, used as screen coating on cathode-ray tubes, is tremendously stepped up by the Spectroradiometer now in use at RCA's "dream plant" at Lancaster, Penna. Shown being demonstrated by its designer and builder, Austin E. Hardy, 27-year-old head of the Physical Testing Laboratory in the Lancaster luminescent materials plant, the Spectroradiometer precisely analyzes test batches of these materials.

Electron-tube Analog Speeds Research

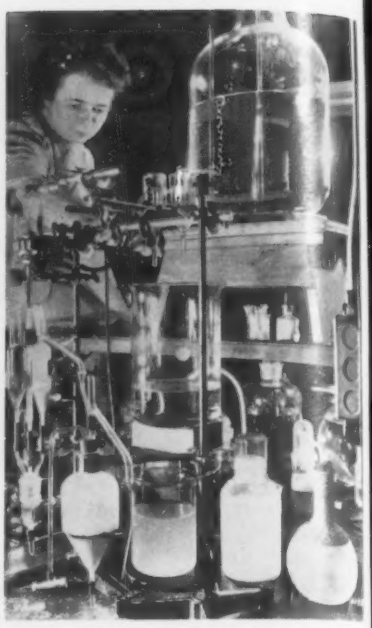
PITTSBURGH, Penna. — A "make-believe" model that tests in a single day electron-tube design which otherwise require three months to try out is aiding Westinghouse research engineers to develop new, more powerful tubes. It consists of a thin sheet of rubber stretched across a frame about the size of a small dining room table. Tiny



bronze balls simulate electrons; wooden blocks act as tube elements; hills and valleys in the rubber simulate field intensities and gradients.

The arrangement of the hills and valleys determines the path of a ball and its velocity. Measuring the time it takes for the ball to roll from one part of the table to another enables engineers to calculate the speed of electrons in a tube. This determines the voltage needed for the particular part of the tube.

To find the proper spacing and optimum shape of tube elements, wooden



RESEARCH ON PHOSPHORS—The flow of dispersing fluid is being adjusted in an elutriator used for grading luminescent powder according to particle size. This research is part of a program at Philips Laboratories, Irvington, N. Y., directed toward the development of improved screens for cathode-ray tubes. The luminescent powder is carried through the apparatus by a small flow of highly-purified dispersing liquid. Lighter particles are carried upward; heavier particles stay behind. Close control over the flow of fluid is required. Usually the rate is a few drops per minute, the exact number depending on the size of the particles being elutriated.

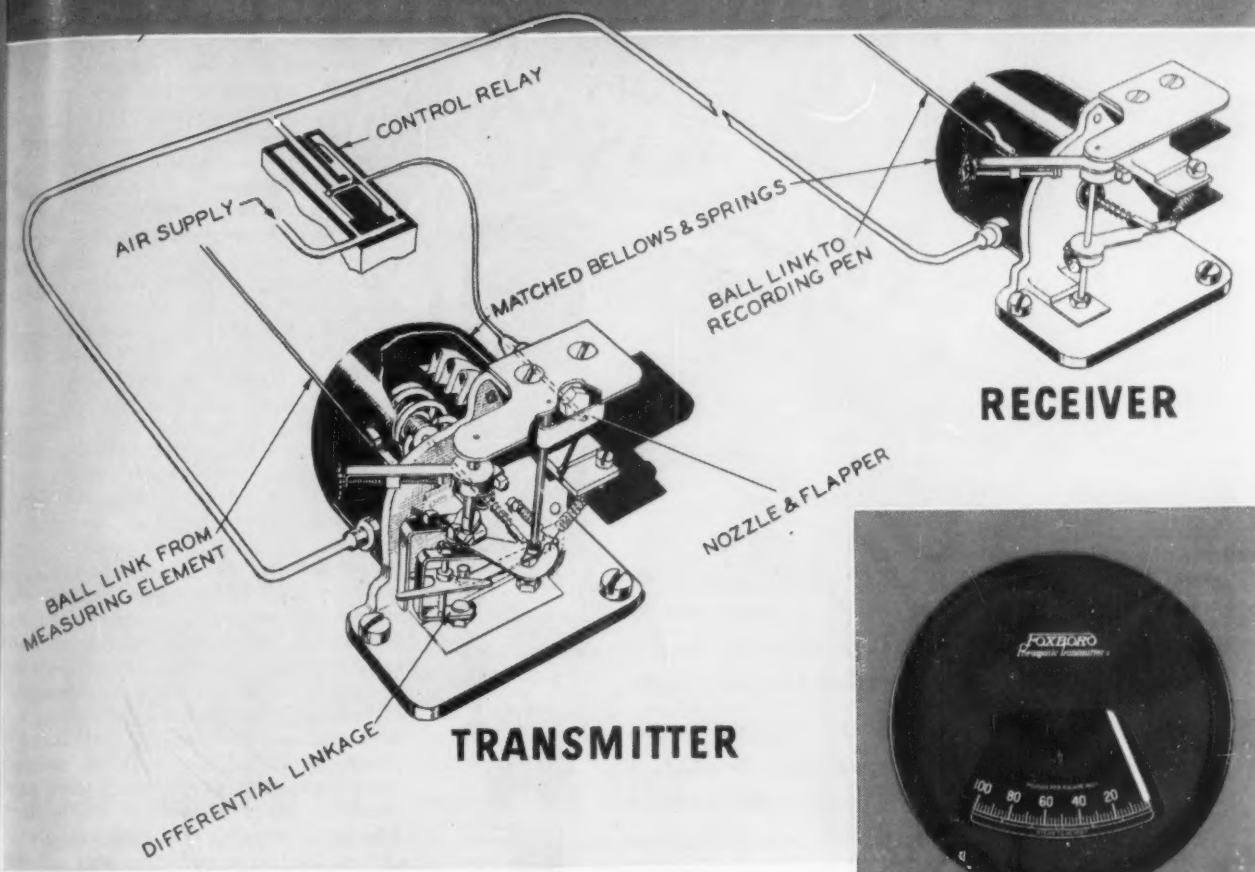
reproductions of various shapes and sizes of cathodes, grids or anodes are used. They help research men find the arrangement that gives the best electron focusing and other desirable characteristics. The photograph shows Westinghouse engineer J. G. Levy launching a make-believe electron—in this case a white marble instead of the small bronze ball ordinarily used. The model permits checking the internal design of a tube in one day as against three months by mathematical trial-and-error methods. Checking minor design changes in an electrode, which used to require a whole day, now takes five minutes.

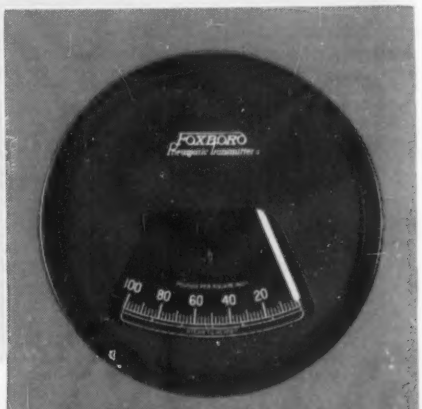
Temperature Measurement Precision to be Increased Tenfold by Thermistors

NEW YORK CITY.—Eyes that see the warmth of a man's body in the dark a quarter of a mile away, that locate ships at night and the chimneys of factories by their heat radiation were new secret weapons ready at war's end.

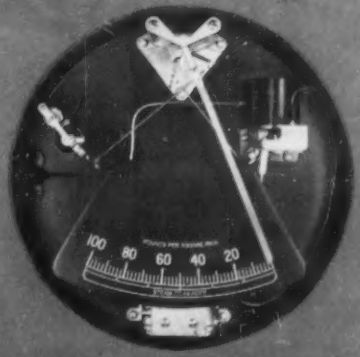
These amazing devices, a product of Bell Telephone Laboratories research and design, were built around tiny elements called thermistors (contraction of "thermal resistors"). These elements

NEW, ADVANCED DESIGN IN PNEUMATIC TRANSMISSION!





The New Foxboro Pneumatic Transmitter . . . for flow, pressure, temperature, liquid level, etc.



Inside view, showing simple construction, complete accessibility of parts.

FEATURING *linear calibration,* the new Foxboro Model 42 Pneumatic Transmission System introduces a new standard of accuracy in long distance measurement of process variables. Transmitter and receiver elements are made to a master calibration standard, assuring precise readings at one or more distant points, with perfect interchangeability of units.

This new transmission system also features a newly designed reference (zero) arrangement which permits adjustment of the indicating pointer without affecting transmitter calibration . . . large, easy-to-read scales . . . standard Model 40 air relay and exclusive ball linkage.

Transmitters are furnished in a standard 12" indicating case, illustrated at the right. Receivers are supplied in indicating or recording models, or the receiver unit may be used as the primary element in any Foxboro air-operated or electric-operated Controller.

The new Foxboro Transmission System is available for flow, pressure, temperature, liquid level, humidity, etc. For complete details, write **The Foxboro Company, 46 Neponset Avenue, Foxboro, Mass., U.S.A.**

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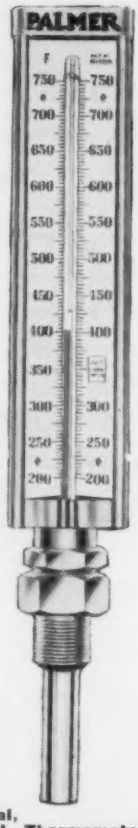
PNEUMATIC TRANSMISSION



● You don't have to squint or strain to get positive readings with the new Palmer Thermometer. The new extruded case permits a larger reading scale, and Palmer's "Red-Reading Mercury" feature stands out vividly . . . like a traffic light on a rainy night.

And both Beauty and Accuracy are combined in this new thermometer. Beautiful chrome finish is standard on 7, 9, and 12 inch case sizes, durable nickel on the 4 and 6 inch case sizes. For full information write for new Bulletin 46-2 and 46-3.

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have such extraordinary electrical sensitivity to heat that they can detect temperature variations as small as one-millionth of a degree Centigrade when used with rugged instruments—not with delicate instruments as Langley had to use in 1886 in order to attain millionth-of-a degree sensitivity.

Developed originally for use in the telephone network and mass-produced by Western Electric Company, supply unit of the Bell System, thermistors not only enabled war-time magic but in peace they promise to increase the precision of temperature measurements tenfold.

Thermistor-controlled devices can scan a darkened landscape and immediately record the presence of some infinitesimally warmer object—such as a man—when it comes within their line of sight. So fine is their perception that from high altitudes they can indicate the pattern of rivers by the difference in heat radiation between land and water. Not only can they detect a ship against its watery background, but they can even distinguish the warmer parts, such as the stacks, from the rest of the ship.

Some of the devices used cathode-ray tube indication as in radar but, unlike radar, they projected no radiation of their own and thus could not be detected by the enemy. Other types present their findings through a loudspeaker or earphones or on graph-paper.

Thermistors were the product of a pre-war research project at Bell Laboratories aimed at finding a means of exercising fine control over speech levels which fluctuated widely with temperature in long-distance telephone conductors. Researchers investigated a group of semi-conductors which had puzzled scientists because their electrical reaction to temperature was the reverse of that in normal conductors: as their temperature increased, their resistance dropped rapidly—an unusual behavior.

Intensive study and experimentation produced materials with such extreme and consistent reactions of this type that they were useful not only in transmission regulation and a variety of other applications in telephony, but promised far-flung developments in heat detection and temperature measurement as well.

For example, some thermometers which use the resistance of a platinum wire as a temperature scale are accurate to a hundredth of a degree. With apparatus no more elaborate, thermistors can gage variations of five ten-thousandths of a degree.

Large-scale adaptation of thermistors was based to some extent on the idea underlying bolometers, sensitive heat-detecting devices such as devised by Langley in 1886, which astronomers have used for many years to measure the heat radiated by distant stars. With the new heat-sensitivity provided by thermistors, it seemed possible to Bell Labs engineers that bolometers could be devised to detect the lesser heat radiated by such non-incandescent objects as men and vehicles, ships, and factory chimneys. Bell Labs designed several equipments of this type which were successfully tested before the war ended. The basic principle was the same in all of them: infrared radiation was collected in a parabolic reflector which could be pointed at specific objects in the same manner as the reflector of an astronomical telescope. At the focus of the reflector was the tiny thermistor element, which was connected with an amplifier to signal any change in the heat it received.

The scientific interest that eventually resulted in thermistors dates back more than a century to the time when Michael Faraday noted a group of substances which were neither conductor nor insulator, and whose resistance variation with temperature bore no resemblance to that of ordinary metals. Until Bell Labs telephone engineers decided that these semi-conductors might be useful in controlling transmission levels in long-distance cables, however, examination of these materials had barely scratched the surface.

Preliminary studies at Bell Labs focussed attention on metallic oxides. Mixtures with the same chemical formula, it was discovered, might have widely varying electrical characteristics if prepared differently. The physical structure, its dimensions, the method of compounding, the amount and intensity of

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SILHOUETTE ILLUMINATION
of clocks, watches and instruments

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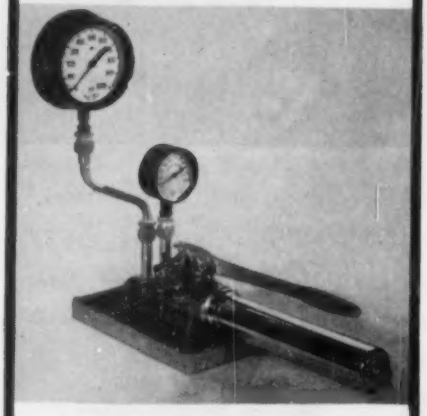
Luminescent Dials

WHY BUY
3 UNITS
when
1 TWIN SEAL UNIT
WILL SERVE 3 WAYS

10,000 psi—no leakage or seepage

1 PORTABLE PRESSURE TESTING
Weight, filled with oil, 8½ lbs.



2 BENCH WORK WITH TEST GAGE
mounted on aluminum drip pan

3 DEAD WEIGHT TESTING
shown with dead weight attachment mounted on unit.
Write for Bulletin

MANSFIELD & GREEN
1051 Power Avenue CLEVELAND 14, O

heat treatment, were as important as the atomic elements of which the substance was composed. Many months of careful investigation led to reproducible materials whose resistance change with temperature not only reversed that of ordinary conductors, but was many times as great. Where copper will double its resistance with a temperature rise of 300°, these semi-conductors can halve their resistance with an increase of only 20°.

First and most widespread application of thermistors was in automatic gain controls for long-distance amplifiers. There is at least one thermistor in most amplifiers in the nation's carrier cable network.

Scope of their task is indicated by the fact that the power transmitted by a length of overhead cable between two amplifiers may vary by a factor of ten with the seasonal variation in cable temperature. Over a long cross-country cable this variation, if unregulated, could pile up to a factor roughly represented by the figure 1 followed by 180 zeros. Thermistors restrict this immense potential change to a variation so small that it is virtually undetectable by the human ear.

It takes only a speck of semi-conductor, sealed in a glass bead hardly bigger than a pinhead, to do the job. It replaced a complicated maze of equipment that did the same job, but not as well. The speck of thermistor material is tapped into the amplifier output so that if the power increases, the thermistor heats up. As it heats, it passes more and more current through itself into an electronic valve which cuts down amplification. On the other hand, when amplifier output decreases below the proper level, the thermistor cools, cutting down the signal to the valve and thereby increasing amplification.

Thermistors have a wide variety of additional uses in and out of telephony. They can be balanced with resistors in voltage regulators to supply a constant output from a varying source or under varying conditions. They were used extensively during the war to supply a standard for measuring the power output of radar sets.

An example of their versatility is their use as time delay elements. It takes time for them to heat up enough to pass the large and sudden surges of current some times fed to them. By varying the design of the particular thermistor and the circuit application, the time delay may be set anywhere from one ten-thousandth of a second to more than ten minutes.

WHEN A FELLER NEEDS CONTROL er Putt

AS NEWEST MAN ON THE CREW YOU DRAW THE JOB OF NURSING SOME SICK INSTRUMENTS (INSTEAD OF A BOTTLE) ON NEW YEAR'S EVE! IDEA BY: H.E. ELENIEWSKI, N.Y. STATE ELEC. & GAS CORP., BINGHAMTON, N.Y.

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[PREDICTIONS FOR 1948]

Analogs

IN Instrumentation, an analog is an apparatus which solves a difficult instrumentation problem much more rapidly and conveniently than by mathematical analysis. In this sense, analogs are MATHEMATICAL instruments or machines —as are all computing machines from the abacus, the planimeter and the slide rule to a whole roomful of mechanics (harmonic analyzers and synthesizers), or a roomful of electrics (network calculators, heat flow analyzers, etc.), or a roomful of hydraulics (other heat flow analyzers, etc.), or a roomful of electronics ("ENIAC," etc.)

In another sense, they may be compared to wind tunnels, to towing basins and even to the fascinating river-basin-in-a-room models of university Civil Engineering Departments. Some Instrumentation analogs are essentially models of this kind, each set up for one problem or one narrow variety of problems.

In the broadest sense, however, Instrumentation analogs —especially those designed in recent years by Instrument Men—are designed to solve not merely one problem or one small variety of problems but an entire category of problems. One such analog can represent the combination of an automatic-control system (almost any kind) and its application (also almost any kind). This is important because, as we've often preached, APPLICATIONS ARE NOT LIMITED TO PROCESSES: an application is a machine, process, airplane, missile, vehicle, weapon, circuit, etc.

A modern Instrumentation analog is an apparatus: (1) in which electrical resistors, inductors, capacitors, etc., represent the mechanical, thermal, hydraulic (and even electrical) inertias, frictions, masses, times, viscosities, capacities, capacitances, temperatures, volumes, pressures, elastances, torques, etc., of an instrument and its application and (2) which produces a solution rapidly and conveniently. This solution may appear as a set of numbers on digital counters, or as traces on an oscilloscope screen, or as scale readings of deflecting-pointer instruments, or as curves autographed on paper charts, etc.

Since all or most analog characteristics are easily adjustable, analogs are used to improve not only the control-instrument characteristics but also the application characteristics. Up to now, analogs have been individually designed by or for instrument manufacturers, research laboratories, educational institutions, etc., and have not been commercially available. Now they are being placed on the market.

1948 will be an analog year. —MFB

Lab to Plant

IT often is said that "today's" industrial instruments were scientific laboratory instruments "yesterday." It never has happened that all—or even most—of one year's new scientific instruments became production aids the next year. It is safe to predict for 1948 that records for such conversions will be broken in at least four fields: (1) NUCLEONICS as in tracers for metallurgical and other industrial processes, practical applications of new counters, scalers and other Manhattan Project instruments, etc.; (2) SPECTROMETRY—whose fields (plural) are multiplying—on BOTH sides of the visible!; (3) PARTICLE ACCELERATORS, specifically betatrons, which a little bird tells us are virtually "carried in stock" by GE, and perhaps one of the other types such as cyclotrons, synchrotrons, cyclo-synchrotrons, relativistic-ion cyclotrons, microtrons, linear-resonator and linear-wave-guide accelerators, etc.; (4) RADAR—by which we mean two different things: (a) entire radar systems for the aviation and marine industries and (b) industrial plant uses for radar components such as differentiators, gates, clippers, flip-flops . . . etc.

1948 will see many lab marvels in overalls. —MFB

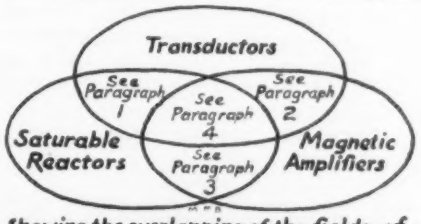
Transductors

IN the last year or two, some prominent users of automatic-control systems have wished for a new type of prime relay or secondary relay combining high gain, INVARIABLE characteristic curve, rapid response, moderate cost, ruggedness and—above all—INFALLIBILITY in the sense that it must not fail UNPREDICTABLY as do electron tubes. At recent instrument mens' meetings, rumors flew about "those magnetic amplifiers the Germans used because they couldn't make enough electron tubes; and which worked better than tubes."

Those magnetic amplifiers constitute one of the TYPES of an important CATEGORY of devices, namely TRANSDUCTORS, which may be defined as d-c.-magnetized a-c. choke coils. This definition describes their operation. Thus they are "trans-inductors"—or transductors for short.

(Of course, transductors are "transducers" or "translators"—as are bellows, thermocouples, orifices, photocells, U-gages, solenoids, pilot valves, strain-gage wires, spring scales . . . and a thousand other means of converting one "cause" or "effect" into a more conveniently utilizable effect in a measuring or control system.)

Why have to use a new term? Because some transductors are saturable reactors and others are not; some of them are amplifiers (10^8 power ratio possible) and others are not. The confusion is natural; even experts don't agree. Not being an expert, we dare try to clear up this situation by showing that it's like others that were met as Instrumentation was being formulated: a case of overlapping fields:



Showing the overlapping of the fields of three different but not mutually-exclusive categories of components

Explanation of the overlapping areas:

(1) In this area the devices are transductors and are saturable reactors, but are NOT amplifiers. An obvious example (for those who hold that an amplifier must MAGNIFY) would be a saturable-reactor form of transductor "used backward" for measuring direct currents of high value.

(2) In this area are transductors which are NOT saturating reactors and which are used for amplification. An example cited by experts is Dr. Elmen's device (U. S. Patents 1,289,418; 1,504,882 and 1,544,381) wherein reactance increases with signal.

(3) In this area are saturable reactors which are NOT transductors and which are used for amplification. An example, according to some experts, is the device of Peterson of Bell Labs (U. S. Patent 1,884,845) wherein energy from a high-frequency source is fed to a low-frequency circuit: it presents an apparent negative resistance to the low-frequency line and is insensitive to the direction of flow of signal; it has no control winding; it amplifies by reason of the easily-saturable core and the resulting non-linearity.

(4) The components in this area may properly be called by any of the three names. An example is, of course, the amplifier invented in 1916 by Dr. Alexanderson, who thereby became THE inventor of the transductor. Amplifying saturable-reactor transductors, say some experts, are those wherein reactance decreases with signal.

We think the various schools of experts hold overly narrow

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and thereby registers the end of the twentieth year of *Instruments'* service to users of measurement and control devices—service to the UNITED STATES OF AMERICA

The entire staff of *Instruments* wishes you

A Merry Christmas and a Happy New Year

views; indeed we think Area No. 4 is (at least potentially) the largest. But we're not an expert!

As a component of measurement and automatic-control circuits the transductor is little-known; therefore an article is in order. The transductor is a PROMISING component of such circuits; therefore we bring you the information-packed article by Harold Rex, explaining its forms and principles in profuse detail.

Transductors should not be considered mere substitutes for electron tubes. It may well be that our publishing this article will cause many tubes to be yanked out and hastily-contrived transductors plugged in, but we predict—not hopefully but confidently—that transductors will be manufactured in many types, varieties and sizes; and will find a large field of applications—a field overlapping the fields of saturable reactors and of electron tubes . . . and of pilot air valves, and of hydraulic valves, and of variable resistors, and of other servo or relay system components!

1948 will be a transductor year. —MFB

THE TRANSDUCTOR

(Sometimes Called "Saturable Reactor" or "Magnetic Amplifier")

By HAROLD B. REX, Principal Engineer, Bureau of Ordnance, Department of the Navy, Washington

INTRODUCTION

THIS article is based on articles in *Archiv für Electrotechnik*, 1942-44, by Th. Buchhold, VDE, Darmstadt; translated by H. B. Rex of the U.S. Navy Department and rewritten for American automatic-control engineers so that only a knowledge of elementary a-c. phenomena is needed for thoroughly grasping all the points brought out in the text and diagrams.

Transductors are defined as alternating-current reactors premagnetized with direct current, both with and without self-excitation. (In this article, a distinction is made between natural and constrained magnetization.)

PART 1.—THE TRANSDUCTOR WITHOUT SELF-EXCITATION

The circuit diagram of a transductor is shown in Fig. 1. Symbols W_1 and W_2 indicate two inductive windings on their respective cores. These windings are connected in parallel and are energized by applying an alternating voltage to the terminals R and S. There are also two windings S_1 and S_2 which are energized by direct current to provide a steady magnetization. Alternating voltages are induced in S_1 and S_2 by transformer action from W_1 and W_2 respectively but these windings S_1 and S_2 are connected in opposition so that the voltages so induced tend to cancel out, for both electromagnetic units are assumed to be identical.

In Fig. 2(a) is shown the assumed magnetization curve for the magnetic cores. The ordinates indicate the total flux ϕ and the abscissas indicate the ampere-turns Θ. In Fig. 2(b), to the right of Fig. 2(a), are shown the two curves which represent the time variation of the total fluxes ϕ_1 and ϕ_2 in the two cores. It is assumed that the ohmic resistances of windings W_1 and W_2 are negligibly small and that the voltage applied to terminals R and S is sinusoidal. These assumptions are made only for the purpose of simplification. The considerations are similar if the voltage is distorted and contains odd harmonics. If the circuit contains ohmic resistance, it is necessary to subtract the voltage drop in the resistance from the applied voltage and to use the remaining reactive voltage in the subsequent analysis. Since the ohmic resistances of W_1 and W_2 are assumed to be negligible, the voltages induced in W_1 and W_2 must be equal to the applied voltage. This induced voltage must be proportional to the rate of change of the flux and it follows that the variation of the fluxes with time must therefore be the same as the variation of the voltage applied to terminals R and S. Since the voltage was assumed to be sinusoidal, the rates of change of the fluxes in the cores are also sinusoidal but the phase lags 90° behind the applied voltage.

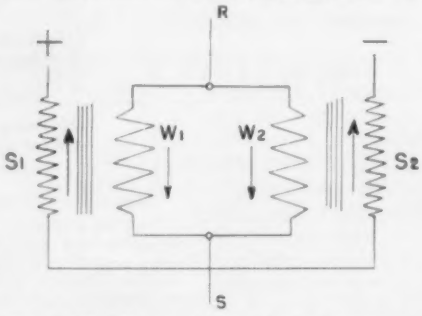

Fig. 1. Transductor with the alternating-current windings W_1 and W_2 connected in parallel.

In Fig. 2(b) are shown the curves of the fluxes ϕ_1 and ϕ_2 with the values of the ordinates projected to the magnetizing curve of Fig. 2(a). The direct current sets up a magnetizing force which causes flux ϕ_1 to be increased by the value ϕ_{DC} and which also causes flux ϕ_2 to be decreased by the value ϕ_{DC} below the time axis. The corresponding values of the ampere-turns Θ_1 and Θ_2, are shown in Fig. 2(c); they are the values of the abscissas of the magnetization curve of Fig. 2(a) determined by projection from the chosen points on the curves for ϕ_1 and ϕ_2 of Fig. 2(b). Thus the ampere-turns Θ may be determined from the curve $\phi = F(\Theta)$ of Fig. 2(a) and the curve $\phi_1 = F_1(t)$ of Fig. 2(b). For example, point A of the curve $\phi_1 = F_1(t)$ of Fig. 2(b) may be projected on the magnetization curve $\phi = F(\Theta)$ of Fig. 2(a); and from this the value of the ampere-turns Θ corresponding to point A can be determined.

The instantaneous value of the ampere-turns may be expressed arbitrarily by a Fourier series; therefore:

$$\Theta = \Theta_{DC} + a_1 \sin(wt - b_1) + a_2 \sin(2wt - b_2) + a_3 \sin(3wt - b_3) + a_4 \sin(4wt - b_4) + \ldots \quad (1)$$

where

Θ_{DC} represents a constant magnetization;

a_1, a_2, a_3, a_4 are the amplitudes of the harmonics of the alternating ampere-turns;

b_1, b_2, b_3, b_4 are the phase angles of these harmonic ampere-turns.

The ampere-turns of the curve Θ_2 of Fig. 2(c) can be determined from the value of the ampere-turns of $\Theta_1 = f(t)$ by substituting $f[t-(T/2)]$ for $f(t)$ and remembering that Θ_2 is negative in value with respect to Θ_1. This is permissible because curve Θ_2 is the negative equivalent of curve Θ_1, but shifted along the time axis by the value of a half-period or $T/2$. Thus:

$$\Theta_2 = -f(t - \frac{T}{2}) \quad (1a)$$

If this value of time, $t - (T/2)$, is substituted for t in equation (1), and advantage is taken of the fact that an angular change of π radians occurs in the time $T/2$, then:

$$\Theta_2 = -\Theta_{DC} + a_1 \sin(wt - b_1) - a_2 \sin(2wt - b_2) + a_3 \sin(3wt - b_3) - a_4 \sin(4wt - b_4) + \ldots \quad (2)$$

Equations (1) and (2) may obviously be separated into two equations, one of which contains the odd harmonic terms (including the fundamental) and the other contains the constant term and the even harmonics. If Θ' is defined as:

$$\Theta' = \frac{\Theta_1 + \Theta_2}{2} = a_1 \sin(wt - b_1) + a_3 \sin(3wt - b_3) + \ldots \quad (3)$$

Similarly, if Θ_{DC} is defined as the steady magnetizing ampere-turns, and if Θ'' is defined as including the even harmonic terms we have:

$$\Theta_{DC} + \Theta'' = \frac{\Theta_1 - \Theta_2}{2} = \Theta_{DC} + a_2 \sin(2wt - b_2) + a_4 \sin(4wt - b_4) + \ldots \quad (4)$$

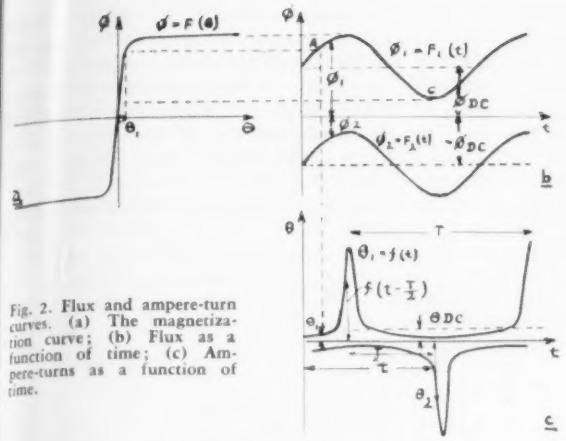

Fig. 2. Flux and ampere-turn curves. (a) The magnetization curve; (b) Flux as a function of time; (c) Ampere-turns as a function of time.

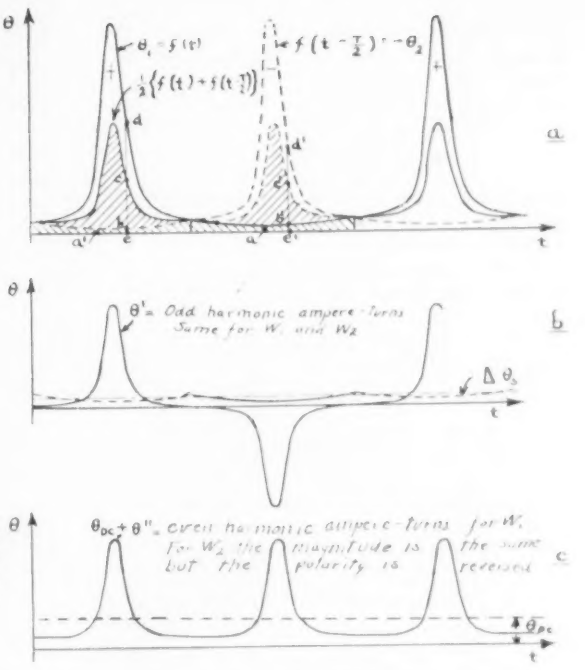

Fig. 3. Ampere-turns as a function of time. (a) Ampere turns required; (b) The odd harmonic ampere turns; (c) The even harmonic ampere turns including the d-c. constant turn.

Equations (3) and (4) may be rewritten in the following form by use of equation (1a):

$$\theta' = \frac{\theta_1 + \theta_2}{2} = \frac{f(t) - f(t - \frac{T}{2})}{2} \qquad (5a)$$

$$\theta_{DC} + \theta'' = \frac{\theta_1 - \theta_2}{2}$$

$$= \frac{f(t) + f(t - \frac{T}{2})}{2} \qquad (5b)$$

These equations permit the separation of the even and odd harmonics geometrically, because θ_{DC} is the average value of the curve $\theta_1 = f(t)$ shown in Fig. 2(c) and which may be determined by the use of a planimeter.

In Fig. 3(a),

$ed = f(t) = \theta_1$

$eb = f(t - \frac{T}{2}) = -\theta_2$

If point c is so chosen that

$$bc = cd = \frac{1}{2}\left[f(t) - f(t - \frac{T}{2})\right] = \theta'$$

$$ec = eb + bc$$

$$= f(t - \frac{T}{2}) + \frac{1}{2}\left[f(t) - f(t - \frac{T}{2})\right]$$

$$= \frac{1}{2}\left[f(t) + f(t - \frac{T}{2})\right]$$

$$= \theta_{DC} + \theta''$$

In Fig. 3(a) the curve $\theta_1 = f(t)$ is shown in solid lines and the curve $-\theta_2 = f[t - (T/2)]$ is shown dotted. It is evident that the curve $\theta_1 = f(t)$ with a phase angle of π radians corresponds to the same curve shifted through the half-period $T/2$.

If the difference between the solid and dotted curves is divided by two, it results, according to equation (5a), in the curve for θ'. This is shown in Fig. 3(a) in which the ordinates in the region marked (+) are shown positive and in the region marked (−) are plotted negatively. In order to obtain the difference $f(t) - f[t - (T/2)]$ the measurements are taken to the boundary curves (a′) and (a) respectively. One half of this value is equal to θ' according to equation 5(a). In Fig. 3(a) the curve for θ_1 is plotted with respect to the lower boundary curves (a′) and (a). Fig. 3(b) shows the odd harmonics θ' plotted with respect to the axis of abscissas instead of the lower boundary curves (a′) and (a).

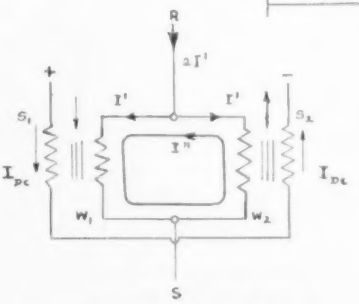

Fig. 4. Paths taken by the odd and the even harmonics of the current in the parallel transductor.

The mean curve of Fig. 3(a), measured with respect to the axis of abscissas, represents, according to equation (5b), $\theta_{DC} + \theta''$, the sum of the even harmonic terms and the steady (direct-current) term. The curve of $\theta_{DC} + \theta''$ is shown separately in Fig. 3(c) from which can be determined the average value which corresponds to the direct current premagnetization and which is produced by the windings S_1 and S_2 of Fig. 1.

The odd harmonics of the alternating current flowing in windings W_1 and W_2 are equal in magnitude and sign but the even harmonics flowing in these windings are equal in magnitude and opposite in sign. The current in each winding is obtained by dividing the ampere turns for the winding by the number of turns. Denoting the odd harmonic current by I', the even harmonic current by I'', and the number of turns in W_1 and in W_2 by w, it follows that:

$$I' = \frac{\theta'}{w} \text{ and } I'' = \frac{\theta''}{w} \qquad (6)$$

The directions in which the odd and the even harmonic currents flow is shown in Fig. 4. As soon as the odd harmonic currents flow between the terminals $R\,S$, the even harmonic current I'' flows as a circulating current in the windings W_1 and W_2. If the number of turns in each control winding S_1 and S_2 is w_{DC}, the steady current flowing through S_1 and S_2 is:

$$I_{DC} = \frac{\theta_{DC}}{w_{DC}} \qquad (7)$$

and, if the windings S_1 and S_2 are connected to a source of current that does not have too much internal impedance, a part of the current I'' can flow through S_1 and S_2.

In Fig. 3(a) are shown the lower boundary curves (a') and (a) just above the time axis. These boundary curves exist because, as shown in Fig. 2(b), the small positive value of flux in the region of point e makes necessary the corresponding positive ampere turns. If the maximum value of the flux were to become somewhat larger, the lower boundary curves a′ and a of Fig 3(a) would approach the time axis, or even lie on the other side of the axis.

It is evident from Fig. 3(c) that the value of the direct-current ampere turns θ_{DC} can be obtained by determining the average value by use of a planimeter. θ_{DC} can also be determined analytically. Consider in Fig. 3(a) the ordinates $\theta_{DC} + \theta''$. Since the average value of θ'' is zero, the direct current can be obtained by measuring the area under this curve with a planimeter. There is also another method, which is to first measure the area, not down to the axis of abscissas, but down to the limiting curve (a′). This area can be obtained by using a planimeter to obtain the area of the odd harmonic curve, Fig. 3(b), except that where this area is negative, it is still to be counted as positive. This can be done practically by measuring the current I', which corresponds to the ampere turns, by means of a rectifier instrument. The average value of the θ' curve as thus determined is denoted by θ'_{DC}. This value does not give the direct-current ampere turns and it is necessary to use a planimeter to measure the

area under the limiting curves (a′) and (a). Assume that the average ampere turns under these limiting curves is $\Delta\Theta_s$ as shown in Fig. 3(b). Consequently there is obtained for Θ_{DC}:

$$\Theta_{DC} = \Theta'_{DC} + \Delta\Theta_s \qquad (8)$$

$\Delta\Theta_s$ can be either positive or negative depending upon the position of the flux ϕ in Fig. 2(b).

In many cases the magnitude of $\Delta\Theta_s$ is negligibly small, particularly where high permeability core material is used. In this case the following approximation can be used:

$$\Theta'_{DC} = \Theta_{DC} \text{ or } I'w = I_{DC}\, w_{DC} \qquad (9)$$

That is, the ampere turns of the odd harmonics are equal to the ampere turns of the total necessary direct current magnetization. If the alternating current is measured with a rectifier instrument to determine the average value, the alternating current is proportional to the direct control current. For the

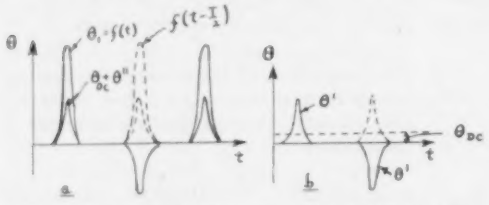

Fig. 5. Ampere-turns with cores with infinitely high permeability. (a) The required ampere-turns; (b) The ampere-turns of the odd harmonics.

connection shown in Fig. 4 the line current is $2I'$ and for the connection shown in Fig. 6 the line current is I'. This characteristic is used in the construction of direct-current voltage changers.

Fig. 5 shows the relation between ampere turns and time for the idealized case of infinite permeability, where equation (9) holds. Fig. 5(a) corresponds to Fig. 3(a) while Fig. 5(b) corresponds to Fig. 3(b) and shows the odd harmonic ampere turns. In this figure the minus values are plotted negatively so as to be shown positively as if rectified. The average value gives the direct current magnetization Θ_{DC}.

Fig. 6 shows another transductor connection. Here the windings W_1 and W_2 are connected in series as contrasted to Fig. 1 in which these windings were connected in parallel. Consider only one of these windings, W_1. If a sinusoidal voltage is applied to this coil it will need the ampere turns Θ' and $\Theta_{DC} + \Theta''$ shown in Fig. 3(b) and 3(c).

It is of interest to learn if the currents, which might cause these ampere turns, can flow. The ampere turns needed for W_2 have equal odd harmonics according to Fig. 3(b). The even harmonics $\Theta_{DC} + \Theta''$ in W_1 and W_2 are also equal in magnitude but opposite in sign. It therefore follows that the current I' of the odd harmonics flows through the windings W_1 and W_2 of Fig. 6, while the oppositely connected windings S_1 and S_2 carry the direct current I_{DC} and the even harmonic current I''. It is here assumed that the even harmonic current can flow without opposition, that is, that the d-c. source does not have too high internal resistance. If the internal resistance of the signal source is high, the control winding may be shunted by a capacitor of sufficient capacitance to allow the even harmonics to flow. Another method for providing a path for the even harmonic currents is the employment of two additional windings connected in opposition like S_1 and S_2 but with the input terminals connected together instead of being connected to a signal source. In such a case, where all of the harmonics can flow, the choke coil is said to possess natural magnetization.

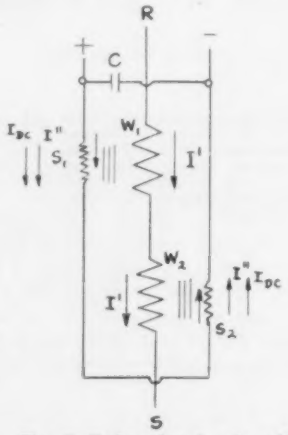

Fig. 6. Paths taken by the odd and the even harmonics of the current in the series transductor.

If the windings W_1 and W_2 are connected in series as in Fig. 6, but with no capacitor or auxiliary windings and if the resistance in the control circuit which includes windings S_1 and S_2 is large, the even harmonics cannot be present. The voltages across W_1 and across W_2 cannot be sinusoidal, but will include even harmonics which are opposite in sign in the two windings. The total voltage across both windings in series is sinusoidal because the opposed even harmonic voltages cancel out. Since the even harmonic current cannot flow, the magnetization is constrained.

The characteristic curve of a transductor shows the relation between the average value of the alternating line current I' and the direct (control) current I_{DC}. In Fig. 7 is shown such a curve which corresponds to applied voltage V. For small control currents the curve at (a) is practically horizontal because the magnetizing current of the transductor flows when $I_{DC} = 0$. This magnetizing current is approximately constant over a small range of control current.

The reason for this is apparent from Fig. 8. The magnetization curve is shown in Fig. 8(a) and the time variation of flux is shown in Fig. 8(b), directly to the right. It should be noted that ϕ_1 has been so chosen that the whole range of flux occurs on the straight part (A_1) of the magnetization curve which passes through the origin. It follows that the necessary ampere turns consist of a constant term and a sinusoidal oscillation of curve Θ_1 is the only part which is of consequence in relation to the alternating current. This oscillation is constant so long as the displacement of the flux curve is not sufficient to cause the flux to exceed the limits of the straight part (A_1), of the magnetization curve. Thus the first part (a) of the curve in Fig. 7(a) is necessarily approximately constant in value.

In Fig. 7 there follows the part of the curve shown at (b) which is nearly

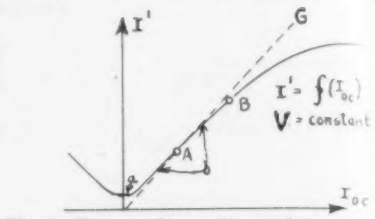

Fig. 7. The transductor characteristic curve showing the line current as a function of the control (d-c.) current for a constant line voltage of V.

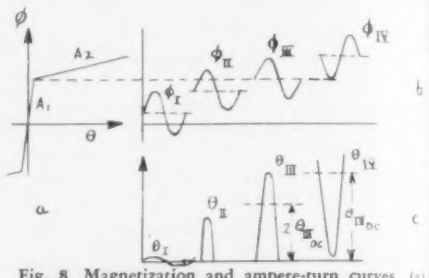

Fig. 8. Magnetization and ampere-turn curves. (a) Idealized magnetization curve; (b) Flux as a function of time; (c) Ampere-turns as a function of time.

straight and nearly proportional to the control current I_{DC}. This corresponds to the range in which the choke coil can operate as an amplifier. The part (b) of the curve does not coincide with the line G drawn at an angle of 45 degrees. This is explained by the fact that, according to Equation (8), not only the ampere turns Θ'_{DC} are needed but also the additional ampere turns $\Delta\Theta_s$ which is positive above point (A) of Fig. 7 and negative point (A). The higher the permeability of the ferromagnetic core, the more nearly will the curve coincide with line G in the region of point (A).

The approximately straight portion (b) of the characteristic curve corresponds to the flux curve ϕ_{II} of Fig. 8(b) which corresponds to the same applied voltage as flux curve ϕ_I but is so displaced that the upper loops cut the saturation line (A_2) of Fig. 8(a) while the rest of the flux curve lies within the range of the part (A_1) of the magnetization curve. The corresponding ampere turns curve Θ_{II} is shown in Fig. 8(c). The ampere turns for the flux range (A_1) are small and if they are considered negligibly small as shown in curve Θ_{II} the time for current flow is smaller than 180 degrees. The requirement that the current loops correspond to a time smaller than 180 degrees is the implied assumption for the amplifying range of the transductor. (See Fig. 5). An examination of Fig. 8 shows that this occurs only with saturation and therefore amplification occurs over a period from zero to 180 electrical degrees as the flux is increased from the condition where the

maximum point on the flux wave just equals the value at saturation to the condition where the axis of the flux wave equals the value of flux at saturation. If the time is exactly 180 electrical degrees (see Θ_{III} in Fig. 8(c)) the corresponding point on Fig. 7 which allows this condition is the end of the straight part (b) which is identified by point (B).

The flux curve ϕ_{IV} is so displaced that the minimum point on the flux wave is the equal to the point determined by the

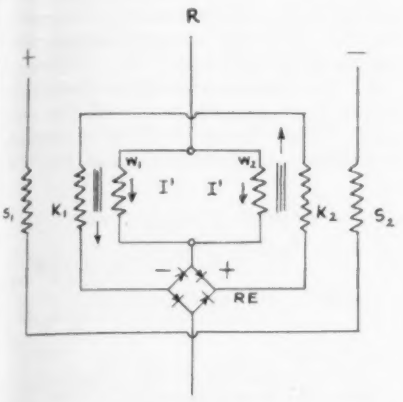

Fig. 9. Parallel transductor with feedback for the purpose of self-excitation.

intersection of lines (A_1) and (A_2) of Fig. 8(a) where saturation occurs. The entire course follows the saturation line (A_2). The corresponding ampere-turns Θ_{IV} are so large that they cannot be shown completely in Fig. 8(c). Since the average value of the flux curve ϕ_{IV} is chosen equal to the maximum value of flux curve ϕ_{III} it follows that $\Theta_{IV\text{-}DC}$ is equal to the maximum value of Θ_{III}. Since Θ_{III} is a half-loop of a sine wave, the ratio of the average value to the maximum value of the half loop is $2/\pi$, and the average taken over 360 electrical degrees is one half of this or $1/\pi$. Thus the ratio

$$\frac{\Theta_{III\text{-}DC}}{\Theta_{IV\text{-}DC}} = \frac{1}{\pi}.$$

If the displacement of the flux curve is increased beyond the value shown for ϕ_{IV} the amplitude of the sinusoidal oscillation of the ampere-turns (neglecting the constant term) becomes constant. Since only the portion (A_2) of the magnetization curve applies, the amplitude of the flux variations must be proportional to the alternating current flowing through the transductor, because the d-c. ampere-turns are supplied by the control current flowing through the control windings S_1 and S_2. The alternating current is therefore constant and the curve in Fig. 7 must bend over to a horizontal line. This is not shown in Fig. 7 because it occurs at values of I_{DC} too large to be shown on this diagram. In all of the preceding discussion it is assumed that the ohmic resistance is negligible.

Suppose that the amplitude of oscillation of the flux curve ϕ_{III} of Fig. 8(b) is increased without displacing the center line. Curve Θ_{III} will then be increased in amplitude without changing the 180° range. The larger flux curve corresponds to a higher voltage and increased ampere-turns and necessitates a larger control current. As the condition III corresponds to the bending of the curve of Fig. 7 which occurs beyond point B, it follows that for higher voltages that

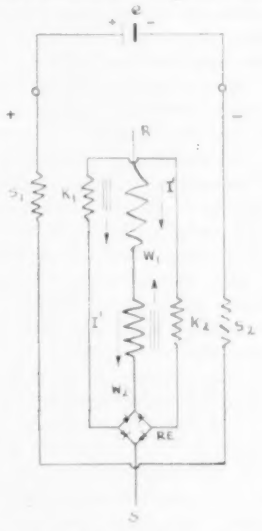

Fig. 10. Series transductor with feedback for the purpose of self-excitation.

this bending (point B) occurs for a higher control current.

Experimentally determined curves for transductors should always indicate the kind of measuring instruments used. Instruments which measure the effective or root-mean-square values generally give greater readings than rectifier instruments which measure the average value.

Part 2. The Self-Excited Transductor

A. Compensated Feedback

The number of ampere turns required for the control windings of the transductor circuits shown in Figs. 1 and 6 are relatively large. According to Equations (8) and (9), the number of ampere turns needed for the control winding S_1, S_2 is of the same order of magnitude as the ampere turns Θ' of the odd harmonics of the alternating current. It should be possible to rectify the alternating current transmitted by the transductor and to use this rectified current to supply part of the necessary control ampere turns, Θ_{DC}, thereby decreasing the control current supplied from the signal source. This feedback process characterizes the self-excited transductor.

In Figs. 9 and 10 are shown the basic circuit diagrams of self-excited transductors which require much smaller control currents than those needed for the analogous transductors without self-excitation shown in Figs. 1 and 6. In Fig. 9 the two a-c windings W_1 and W_2 are connected in parallel with each other and in series with a bridge type of rectifier *RE*. The rectifier supplies pulsating direct current to the windings K_1 and K_2 which produce magnetization in the directions indicated by the arrows on the cores. The arrangement shown in Fig. 10 is similar to that shown in Fig. 9 except that the a-c. windings W_1 and W_2 are connected in series.

Suppose that the current in winding W_1 of Fig. 9 gives rise to an alternating flux ϕ, which has the same position as shown in Fig. 2(b) The corresponding ampere-turns Θ, are shown in Fig.

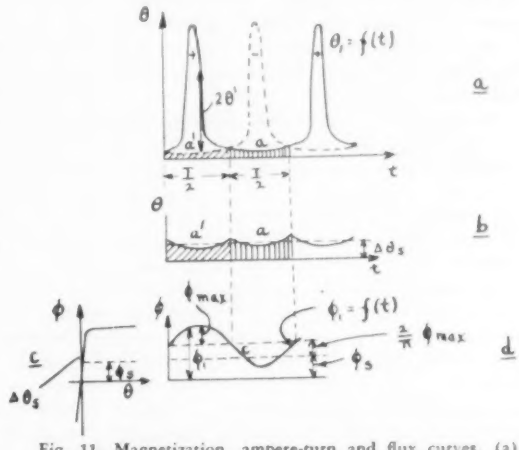

Fig. 11. Magnetization, ampere-turn and flux curves. (a) The required ampere-turns; (b) The ampere-turns which must be supplied by the control winding; (c) The magnetization curve; (d) The flux as a function of time.

11(a). In order to find the magnitude of the odd harmonics, Θ_1 is drawn in solid lines and Θ_2 is drawn negatively in dotted lines and is displaced a half-period, as was done in Fig. 3(a). The vertical distance from the curve Θ_1 to the limiting curve a' is then equal to $f(t)-f[t-(T/2)]$, and as was shown before, equal to $2\Theta'$, twice the value of the odd harmonic ampere-turns. If the current which flows through W_1 is assumed to be I', which is the current corresponding to Θ', the value of the ampere-turns generated by this current in combination with winding K_1 is determinable. It must first be noted that the current flowing through parallel winding W_2 has exactly the same odd harmonics as the current flowing through winding W_1. Because of the parallel connection the double current,

$$2I' = 2\Theta'/w$$

flows through windings K_1 and K_2. The number of turns in K_1 and K_2 is therefore only half as great as in W_1 and W_2, and hence $w/2$. Thus the condition is obtained in which the ampere turns of the odd harmonics are the same in W_1 and K_1, irrespective of signs and are of the value Θ'. In a given half-period the ampere turns are produced by the alternating current in W_1 and the rectified alternating current in K_1, and the sum of the ampere turns is $2\Theta'$ as shown in Fig. 11(a).

In the next half-period, the current flows through winding K_1 in the same direction as before because the rectifier permits only a unidirectional current to flow, while the current flowing through W_1 has reversed in direction. The ampere-turns, additive in the previous half-period, are now subtractive because

they oppose each other. Since the ampere-turns are exactly equal in magnitude they cancel, and thus compensate each other exactly. *This condition defines the self-excited transductor with compensated feedback.*

It is evident from curve Θ of Fig. 11(a) that during the first half-period the two windings W_1 and K_1 supply $2\Theta_1$ ampere turns. In addition to this, there are required the ampere-turns indicated by the distance of the limiting curve (a′) from the axis of abscissas. These ampere-turns, which are shown by diagonal shading, must be supplied from some source.

During the second half period, the windings W_1 and K_1 produce no ampere-turns. There are required, however, the ampere-turns which lie below the limiting curve (a), shown by vertical shading. These ampere-turns are the same in magnitude as in the first half-cycle because the areas under the two curves are equal. These additional ampere-turns shown under curves (a′) and (a) of Fig. 11(a) are drawn to a larger scale in Fig. 11(b). The dotted line shown in Fig. 11(b) shows average value and defines the steady ampere-turns $\Delta\Theta_s$ which must be supplied by the control winding to make possible the flux curve shown in Fig. 2(b).

Fig. 11(b) shows that curves a′ and a which have the average value $\Delta\Theta_s$ possess even harmonics which are necessary to fulfill the requirements of curve Θ of Fig. 11(a).

In the parallel transductor circuit of Fig. 9 the even harmonics in winding W_2 are 180° out of phase relative to the even harmonics in winding W_1. These even harmonics therefore flow as a circulating current in windings W_1 and W_2 and are therefore not necessarily derived from the source of alternating current connected to terminals R and S. The even harmonics may also flow in the windings S_1 and S_2 insofar as the impedance of the signal source permits. Actually, part of the even harmonics flow in W_1 and W_2 and part flow in S_1 and S_2. When the current in W_1 and W_2 is equal to

$$I' = \Theta'/w$$

the necessary ampere-turns Θ are provided and the transductor possesses natural magnetization.

The part of the curve marked (a) in Fig. 11(b) corresponds to the part of the flux curve marked (c) in Fig. 2(b). A part of Fig. 2(b) is repeated in Fig. 11(d). If it is assumed that the slope of the magnetization curve $\phi = f(\Theta)$ of Fig. 11(c) is a straight line in its initial rise, then curve (a) of Fig. 11(a) must be sinusoidal, just as was the case for the curve (c) of Fig. 11(d). Here the sine loops in (c) are S times as great as in (a), because S is the initial slope of the magnetization curve. It is here assumed that the entire range of curve (c) lies below the knee of the magnetization curve. The average value of $\Delta\Theta_s$ must, therefore, correspond to the average value of the flux loops (c). If the average value of the flux for curve (c) is denoted by ϕ_s, then ϕ_s is separated from the zero line of the flux curve ϕ by the amount $2/\pi \times \phi_{max.}$ The projection of the value of ϕ_s from Fig. 11(d) to the magnetization curve of Fig. 11(c) defines the steady magnetization which must be supplied by windings S_1 and S_2. The greater the permeability of the core, the greater is this slope of the magnetization curve and the less the value of the ampere-turns which must be supplied by S_1 and S_2. If, for example, the value of $\Delta\Theta_s$ (for which only a small amount of control power is needed) is increased, the flux ϕ_s is increased. The applied voltage has not been changed and the flux oscillations of Fig. 11(d) remain the same, but the whole curve is raised and, as a consequence, the alternating ampere-turns Θ must be greatly increased, including the odd harmonics Θ'. A small change in the steady magnetization produced by the control winding causes a very great change in the alternating current. If the permeability of the flux curve ϕ, and hence the slope S, were infinitely large, then an infinitestimal control current would cause the alternating current to change through the whole range of the reactor. The higher the permeability of the core material, the smaller is the required control power.

Consider the important case of zero control current in windings S_1 and S_2. In this case the flux curve of Fig. 11(d) must be displaced downward until the line ϕ_s, which is drawn at a distance of $2/\pi \times \phi_{max.}$ below the center line of the flux curve, coincides with the axis of abscissas where $\phi_s = 0$. This construction is shown in Figs. 12(a) and 12(b) where the center line of the flux curve lies above the axis by the distance $2/\pi \times \phi_{max.}$ This is the position that the flux curve will take when there are no steady ampere turns and the first rise of the curve $\phi = f(\Theta)$ is nearly a straight line. The treatment of a non-linear rise is also possible but not in so simple a manner.

If the applied alternating voltage is increased, the flux curve becomes larger but its position relative to the abscissa remains unchanged. The maximum value of the flux, which is equal to $(1 + 2/\pi)$ $\phi_{max.}$, then becomes greater, thus increasing the a-c. ampere-turns and consequently the alternating current. The alternating current may be increased or decreased by a corresponding change in the control current or in the applied alternating voltage.

Fig. 10 shows the choke windings W_1 and W_2 and also the compensating windings K_1 and K_2 connected in series. Since K_1 and K_2 are presumed to carry the same current as W_1 and W_2, they must have the same number of turns in order that in any given half-wave the ampere-turns in W_1 and K_1, or W_2 and K_2 are equal. *This condition defines full compensation.*

The control windings are S_1 and S_2. If the considerations similar to those raised in connection with Fig. 11 are repeated, it will again become evident that to obtain the ampere-turns Θ_1 of Fig. 11(a), additional ampere-turns are needed which are indicated by curves (a′) and (a). These ampere-turns, which have exactly the opposite direction in W_2 as compared to W_1, can be supplied by the windings S_1 and S_2 which are fed from a current source e. If the even harmonics are to flow, it is essential that the current source e should have only a small internal impedance. If this is too large, the current source may be shunted by a capacitor. Under these conditions, and in the steady state, the circuits shown in Figs. 9 and 10 operate similarly and both circuits possess natural magnetization.

For the transient condition there is a difference in the operation of the circuits of Figs. 9 and 10. When a voltage is suddenly applied to S_1 and S_2, the

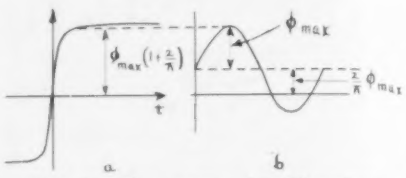

Fig. 12. Flux curves: (a) Magnetization curve; (b) Flux as a function of time.

current in S_1 and S_2 and also the d-c. flux increase slowly. The delay in building up of the steady flux is greater for the connections shown in Fig. 9 because a transient circulating current is induced to flow in W_1 and W_2 which provides the opposite magnetization to the current in S_1 and S_2. This prevents the rapid change of flux. The connections shown in Fig. 10 should therefore be used when a small time constant is desirable. In the preceeding discussion it was assumed that the ampere-turns provided by W_1, W_2, K_1, and K_2 are equal, so that full compensation is provided.

B. Under-compensated Feedback

If the circuit shown in Fig. 10, instead of being fully compensated, is designed so that W_1 and W_2 have w_1 turns while K_1 and K_2 have w_2 turns, and that w_2 is less than w_1 in numerical value, the transductor is said to be under-compensated. Assume that the alternating current, $I' = \Theta'/w$ is the same as in the case of compensated feedback (in which w_2 equals w_1). In order to obtain the same ampere-turns as before, assume that there is connected in series with K_1 an additional hypothetical winding with $w_1 - w_2$ turns so that the self-magnetization will be the same as with full compensation. This hypothetical winding will produce

$$\frac{w_1 - w_2}{w_1}\,\Theta_1 \text{ ampere-turns.}$$

If we let

$$k = w_2/w_1$$

denote the degree of feedback, noting that k equals unity for compensated feedback, then:

$$\frac{w_1 - w_2}{w_1}\,\Theta' = (1-k)\,\Theta'$$

This is a function of time and is

plotted in Fig. 13, and can be resolved into a constant term $\Delta\Theta_{DC}$ plus a superimposed oscillation composed of the even harmonics. The value of $\Delta\Theta_{DC}$ is given by:

$$\Delta\Theta_{DC} = (1-k)\ \Theta'_{DC}$$

where Θ'_{DC} is the rectified average of Θ'. The ampere-turns plotted in Fig. 13 need not, however, be supplied by the hypothetical winding but can be furnished by an increase of current in the control windings S_1 and S_2 so that the additional ampere turns equals $\Delta\Theta_{DC}$. The even harmonics can also flow through the control windings S_1 and S_2 if the current source e is of low internal impedance or is shunted by a capacitor. It is apparent from these considerations that considerably more ampere-turns are needed in the control winding S_1 and that greater even harmonics flow

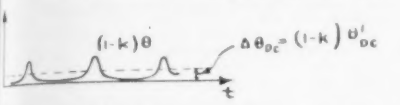

Fig. 13. Additional ampere-turns required with under-compensated feedback.

Fig. 14. Additional negative ampere-turns needed with over-compensated feedback.

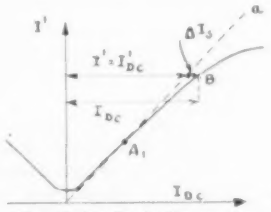

Fig. 15. Feedback diagram for compensated feedback.

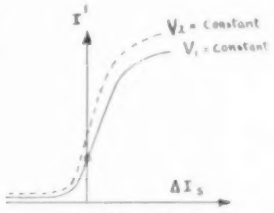

Fig. 16. Transmitted alternating current as a function of d-c. control current for compensated feedback.

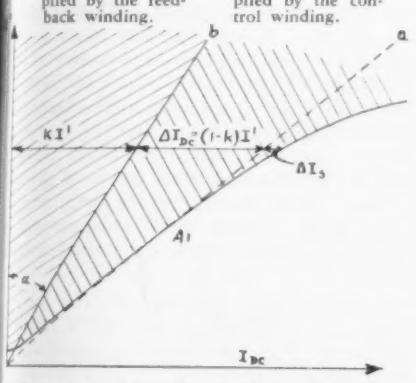

Fig. 17. Feedback diagram for under-compensated feedback.

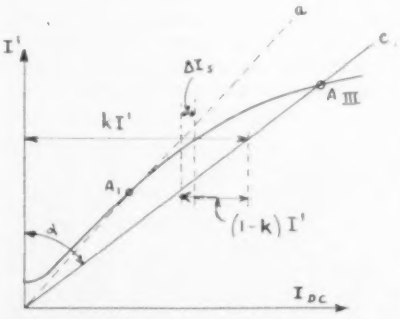

Fig. 18. Feedback diagram for over-compensated feedback.

than in the fully-compensated transductor. For under-compensated feedback, the control winding needs $\Delta\Theta_{DC}$ plus $\Delta\Theta_s$ ampere-turns, where $\Delta\Theta_s$ is the value needed for full compensation and $\Delta\Theta_{DC}$ is the addition needed because of under-compensation. Usually $\Delta\Theta_{DC}$ is considerably greater than $\Delta\Theta_s$. If w_2 is zero, the transductor has no self-excitation and $\Delta\Theta_{DC} = \Theta'_{DC}$.

C. Over-compensated Feedback

Over-compensation is identified by the condition in which the number of ampere-turns of the feedback winding exceeds the ampere-turns of the a-c. winding. In Fig. 10, for example, over-compensation would require that W_2 exceed W_1. In order to have the same number of ampere turns Θ_1 as for full compensation, it therefore is necessary to supply additional negative ampere-turns as shown in Fig. 14. The average, $\Delta\Theta_{DC} = (1-k)\ \Theta'_{DC}$, which is negative because k is greater than unity, corresponds to a negative direct current which is needed to reach the condition of full compensation. This condition, shown in Fig. 14, is not stable. If the transmitted alternating current increases, more negative ampere-turns are needed and consequently an increase in $-\Theta_{DC}$ implies additional negative control current. The direct current in the control windings does not increase because this current is provided by a separate and independent current source. Consequently, there is an excess of positive ampere-turns which shifts the flux curve into the region of higher flux density and causes the alternating current to increase further, etc., until a new position of equilibrium is reached. This can be found by trial and error, by shifting the flux curve of Fig. 2(b) upwards until the steep part of the magnetization curve is passed and a point is found at which the required steady ampere-turns are equal to those supplied by the control windings S_1 and S_2. These relations are clarified as a result of consideration of the feedback winding, which follows below.

D. The Feedback Diagram

The diagrams which have been considered give a complete survey of the ampere-turn relationships in transductors with feedback, and of the higher harmonics and the direct current needed for control. There follows a discussion, with a diagram, from which the value of the control current needed for different degrees of feedback may be determined.

Figs. 7 and 15 show current curves of I' as a function for transductors without feedback. If the core possessed infinite permeability, the actual transductor characteristic curve departs from the 45° line as described in connection with Fig. 7. With fully-compensated feedback as shown in Fig. 10, the rectified alternating current is sent through feedback coils to provide self-excitation. These coils have the same number of turns as the a-c. coils and they carry a magnetizing current I'_{DC} which is equal to the average value of the alternating current I' as measured by a rectifier type of instrument.

If the transductor is to be operated at the value of I' determined by point B of Fig. 15, an additional current ΔI_s is needed to provide the necessary ampere-turns. It is apparent that, for the compensated transductor, the current I'_{DC} will be supplied to the feedback winding and that only a small current ΔI_s will have to be provided to the control winding. The greater the effective permeability of the core, the more closely will the characteristic curve approach line (a), the so-called feedback characteristic, and the smaller will be the required value of ΔI_s. When ΔI_s is not supplied, the control current is zero and the current through the transductor is that corresponding to point A_1.

By use of the diagram, Fig. 15, it is possible to construct the curve for $I' = F\ (\Delta I_s)$ of Fig. 16 which shows the relation between the alternating current I' and the control current ΔI_s for a compensated transductor.

The condition of under-compensation is depicted in Fig. 17 in which the feedback line is drawn so that the ampere-turns produced by this winding correspond to a current kI'. An additional magnetizing current $\Delta I_{DC} + \Delta I_s$ must then be provided; and this is considerably greater than for the fully-compensated feedback. If the feedback is zero the feedback line (b) coincides with the vertical axis and the value $\Delta I_{DC} + \Delta I_s$ becomes equal to the value of I_{DC} needed for the reactor without feedback. It is evident from Fig. 17 that $k = \tan\alpha$.

The feedback line for the condition of over-compensation is shown in Fig. 18 as line (c). Here the additional control current ΔI_{DC} must be negative to obtain the same value of I' as before. This condition is not stable (as was pointed out in the discussion related to Fig. 14). A stable condition is first attained at large values of I' such as would exist at point A_{III} where the control current is zero. The strongly over-compensated transductor is not generally usable for control purposes. Slight overcompensation of the feedback is possible if the feedback line has a well-defined point of intersection with the

approximately straight-line portion of the characteristic curve. It has been found that, for transductors with low-loss windings and with cores with high permeability and low losses and minimum magnetic leakage, the fully-compensated condition can scarcely be exceeded without causing instability. Under the less ideal conditions of more copper or core loss, lower permeability or magnetic leakage, the over-compensation may be increased slightly, but, in general, full compensation is the condition of greatest interest in the construction of self-excited transductors.

Part 3. The Transductor with Constrained Magnetization.

In the foregoing discussion, the transductor was defined as consisting of two similar transductor elements, with a-c. windings W_1 and W_2 which were connected in parallel or in series. It was assumed that the voltage applied to each of these windings was sinusoidal. The subsequent procedure consisted in determining the needed ampere-turns and then proving that the corresponding currents could flow in the circuits of the transductor. This was found to be true in the transductor circuits previously considered and these circuits were therefore said to possess natural magnetization.

There remain to be considered those transductor circuits in which only a direct current can flow in the control windings S_1 and S_2, the nature of this circuit being such as to suppress the flow of alternating currents. This condition is brought about by the existence of high resistance or high inductive reactance in series with the control windings. In Fig. 4 is shown a parallel transductor without feedback. The even harmonics can flow in W_1 and W_2 so that an inductive reactance may be connected in series with S_1 and S_2 without making a change in the ampere-turns. The parallel transductor without feedback is therefore always naturally magnetized. The same is true also for the arrangement shown in Fig. 9 which shows the parallel transductor with self-excitation.

Fig. 6 shows the series transductor without feedback. If the control windings are of low resistance and if the signal source has a low resistance and reactance, or if a capacitor of adequate size shunts the control windings, then the even harmonics can flow in the control windings S_1 and S_2.

These even harmonics are of appreciable magnitude and correspond to Θ'' shown in Fig. 3(c). When the flow of even harmonic currents I" is impeded by the action of a choke coil as shown in Fig. 19(e), it no longer is possible to assume that sinusoidal voltages are applied to W_1 and W_2 individually, even though the line voltage is sinusoidal. The voltages across W_1 and W_2 will then include even harmonics which are opposite in phase so that these even harmonics cancel out of the total voltage. Since the voltage across each winding W_1 and W_2 is not sinusoidal (because even harmonic currents cannot flow) the magnetization is constrained.

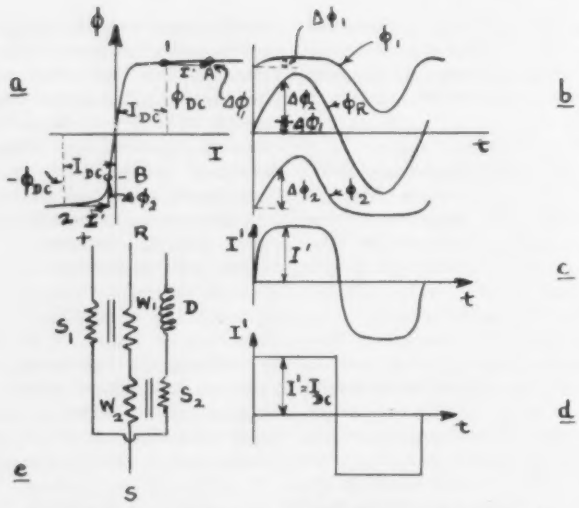

Fig. 19. Magnetization, flux and current curves for the condition of constrained magnetization. (a) Magnetization curve; (b) Flux as a function of time; (c) Current as a function of time; (d) Current as a function of time with a core with no leakage flux and with an infinitely high initial permeability; (e) Series transductor with a choke coil in the control circuit.

Fig. 19(a) shows the flux ϕ as a function of the magnetizing current I. As the line voltage must equal the sum of the instantaneous voltages across W_1 and W_2, so also must the "total" or "resultant" flux be equal to the instantaneous sum of the individual fluxes, or:

$$\phi_R = \phi_1 + \phi_2$$

for it has previously been assumed that the resistance of windings W_1 and W_2 was negligible and therefore the induced voltage in each transductor element must, of necessity, equal its terminal voltage. The "resultant" flux ϕ_R is shown in Fig. 19(b) as sinusoidal, corresponding to the sinusoidal line voltage. If, now, a direct current I_{DC} flows in windings S_1 and S_2 this will give rise to a positive flux linking winding W_1 and a negative flux linking winding W_2 because the control windings are connected so that induced alternating voltages oppose. See points 1 and 2 of Fig. 19(a).

The alternating current I' flows through both windings W_1 and W_2 in series. At any given instant the flux linking winding W_1 is therefore equal to ϕ_{DC} plus an increment of flux $\Delta\phi_1$, so that we have the following equation representative of point A of Fig. 19(a):

$$\phi_1 = \phi_{DC} + \Delta\phi_1$$

Similarly, the flux $-\phi_{DC}$ corresponding to point 2 is modified by the alternating current to give a flux indicated by point B, so that:

$$\phi_2 = -\phi_{DC} + \Delta\phi_2$$

Adding these two equations:

$$\phi_R = \Delta\phi_1 + \Delta\phi_2$$

This relation may be used to find the current taken by the transductor, using the following method:

Assume an arbitrary value for the current I' and use Fig. 19(a) to determine the flux increments $\Delta\phi_1$ and $\Delta\phi_2$ which are necessitated by this value of current. Enter the sum of $\Delta\phi_1$ and $\Delta\phi_2$ as an ordinate on the curve for ϕ_R of Fig. 19(b). The corresponding abscissa gives the time at which the assumed value of current I flowed and the necessary value of resultant flux ϕ_R linked the windings W_1 and W_2, thus providing one point for the current-time curve. Proceeding in this way, point by point, the current-time curve of Fig. 19(c) may be constructed. This curve is very different from the curve for Θ of Fig. 3(b) which shows how the current varies with time for natural magnetization.

This procedure allows also the construction of the curves for ϕ_1 and ϕ_2 shown in Fig. 19(b). It is apparent from these curves that ϕ_1 contributes little to the variation of the resultant flux ϕ_R so long as ϕ_1 lies in the saturated part of the magnetization curve. In this condition the change in the resultant flux is due mostly to ϕ_2. Correspondingly, flux is due mostly to ϕ_2. Consequently, when ϕ_2 lies in the saturated part of the magnetization curve, the greater part of the variation of the resultant flux is due to ϕ_1. The voltages across W_1 and W_2 may be obtained by differentiating ϕ_1 and ϕ_2 respectively. These voltages will have even harmonics, just as do the fluxes ϕ_1 and ϕ_2.

The current curve for I' has an interesting shape in case the core has, in effect, an infinitely great initial permeability and a horizontal saturation curve. In this case, the current wave consists of rectangular half-loops as shown in Fig. 19(d). The amplitude I' is then equal to the direct current I_{DC}, assuming an equal number of turns in all coils. Rectification of the "square-wave" alternating current gives a facsimile of the direct current which flows in the control winding. This characteristic is used in the construction of static d-c. converters.

Fig. 20 depicts a series transductor with self-excitation, or feedback, simi-

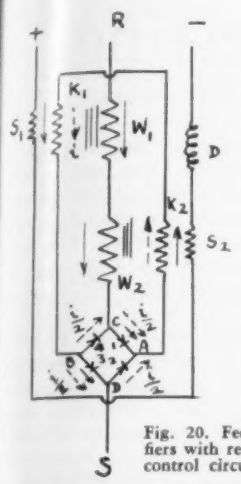

Fig. 20. Feedback amplifiers with reactance in the control circuit.

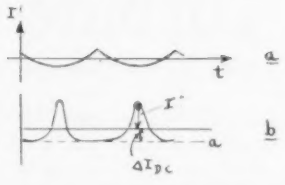

Fig. 21. Even harmonics. (a) For compensated feedback; (b) Additional even harmonics for under-compensated feedback.

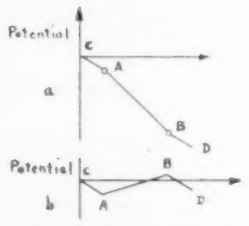

Fig. 22. Potential differences in the rectifier. (a) For natural magnetization; (b) For constrained magnetization.

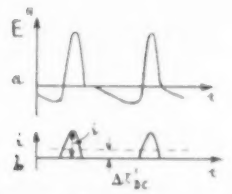

Fig. 23. Voltage and current curves as functions of time. (a) Additional voltages induced in the feedback coils; (b) Additional current caused to flow by the induced voltages.

lar to the circuit of Fig. 10, except that an inductive reactance has been added in series with the control windings S_1 and S_2 in order to suppress any harmonic variation of the current in this circuit so that the flow may be assumed to be steady direct current. With fully-compensated feedback, the even harmonics shown in Fig. 11(b) are small relative to the total required ampere turns Θ_1 shown in Fig. 11(a); and therefore it may be assumed that the suppression of the even harmonics, shown again in Fig. 21(a), will not materially change the current flow of the transductor.

When the transductor is partly compensated, there tend to exist the even harmonics shown in Fig. 13 and repeated in Fig. 21(b), in addition to the even harmonics shown in Fig. 21(a). With natural magnetization, these even harmonics can all normally flow in the control winding, but in the circuit shown in Fig. 20 the choke coil suppresses the flow of these alternating currents. Consideration should therefore be given to this circuit to determine if even harmonic currents may flow in the feedback windings.

The solid arrows shown in Fig. 20 indicate the direction of the magnetizing currents which flow during a given half-cycle through the reactive windings W_1 and W_2, the element 1 of the rectifier, the feedback windings K_2 and K_1 and finally through element 3 of the rectifier to terminal S.

It is now possible to determine if the even harmonics can flow in the circuit consisting of K_1 and K_2 and the rectifier. Since the current shown in Fig. 21(a) is small compared with that shown in Fig. 21(b), only the latter is taken into consideration.

The additional current, i, which can flow in the feedback windings and rectifier, is shown by the dotted arrows of Fig. 20. Because of the rectifier this current can flow in only one direction, and cannot, therefore, flow as alternating current in Fig. 21(b). This curve must therefore be moved upward far enough so that the current never becomes negative. The same result is obtained by using the line (a) as axis of abscissas. The current then consists of a direct current ΔI_{DC} and the superimposed even harmonic current I''.

In the consideration of Fig. 13 with respect to natural magnetization it was learned that the necessary direct current had to be supplied by an additional direct current in the control winding. In the circuit of Fig. 20 this is not necessary if the losses are all zero, because the necessary direct current can flow through the feedback circuit.

It therefore is evident that the alternating current is the same, for the same ampere-turns in the control windings S_1 and S_2, regardless of the degree of under-compensation, since the necessary additional even harmonic current and the additional direct current ΔI_{DC} can flow in the feedback circuit. It is not strictly correct to speak of constrained magnetization in this case. It should be noted also that this case is conceivable only when all losses in the windings and in the rectifier are zero. When losses are present, additional voltages must be induced in the feedback windings to cause the current of Fig. 21(b) to flow. This current will be distorted, since its only because of deviations from the correct form that the induction of even harmonics in the two reactive windings and the two feedback windings becomes possible. The even harmonics which are induced in reactive windings W_1 and W_2 are of opposite polarity to the voltages induced in the feedback windings K_1 and K_2 so that they cancel out of the total applied voltage.

Fig. 22 shows the potential diagrams for the rectifier and feedback circuit for a particular instant of time. In the case of natural magnetization in which choke coil D is not present, there will be several potential drops as shown in Fig. 22(a). The fall in potential from C to A occurs in rectifier element 1. The drop from A to B is the IR drop in the feedback windings K_1 and K_2. The drop from B to D occurs in rectifier element 3.

If the additional current i is to flow through the rectifier, the current $i/2$ will flow through rectifier element 4, and therefore point B must have a higher potential than point C. According to Fig. 22(a) this is not factual. It is therefore necessary that additional voltages be induced in the windings K_1 and K_2 to increase the potential of point B to the value shown in Fig. 22(b). In this figure, point B has a sufficiently higher potential than point C so that the current $i/2$ can flow through rectifier element 4.

In Fig. 23(a) is shown an oscillogram (measured with an auxiliary winding) of the additional voltages induced in K_1 and K_2. There is a potential increase corresponding to Fig. 22(b) only for the positive loops. For negative loops, element 4 of the rectifier of Fig. 20 prevents the flow of current so that i is zero. The current i will therefore have a wave-form which is represented more nearly by Fig. 23(b), in which the current is zero for part of the time, than by Fig. 21(b). During the instant of time in which the direction of current flow is indicated by the arrows shown in Fig. 20, the rectifier elements 4 and 2 carry $i/2$ and in the next half wave the rectifier elements 1 and 3 carry $i/2$ (i being a current in addition to that taken from the alternating power source).

The smaller the losses in K_1, K_2 and the rectifier, the flatter will be the potential curve in Fig. 22(a), and the smaller will be the additional voltages induced in K_1 and K_2. The current curve of Fig. 23(b) will be distorted less and will be diminished in comparison to the theoretical curve of Fig. 13, while the direct current $\Delta I'_{DC}$ will be increased. This is favorable because it indicates an increase of the alternating current through the transductor. If the choke coil D of Fig. 20 is shorted out of the circuit, the alternating current will increase when the short-circuit connection is removed. Because of the rectifier effect already described, an additional direct current $\Delta I'_{DC}$ flows and produces exactly the same effect as an increase of control current in S_1 and S_2.

The magnetization may therefore be considered to be more or less constrained as a function of the losses.

In the case of compensated feedback with natural magnetization, only the current of Fig. 21(a) flows in the control winding, not the current of Fig. 21(b). In practice, however, current peaks corresponding to Fig. 21(b) can also be present, owing apparently to the departure from the assumed conditions. In many cases these can be explained by the fact that the rectifier does not rectify perfectly. Despite apparent compensation, the current flowing through windings K_1 and K_2 is less than in W_1 and W_2 at the time when the peaks occur and, in respect to the even harmonics, the transductor acts as if it were somewhat under-compensated. In this case also a choke coil in the control circuit increases the alternating current.

Instrumentation in Turbine Testing*

By A. BAYARD SISSON, Station Efficiency Engineer, Public Service Company of Northern Illinois.

EFFICIENT production of power in a large central station depends upon the proper operation of its component parts. The turbine or prime mover, in converting the heat into mechanical energy, supplied by the boiler, utilizes some 75% to 80% of the total station energy input. Therefore, turbine efficiency will in large measure determine station thermal performance.

Maintaining and determining the efficiency and performance of the prime mover is, of course, one of the major responsibilities of the Test or Results Department of any large central station.

Testing a large turbine to determine its heat consumption involves the services of a large test crew in making frequent readings of many instruments. The formal part of the turbine test, during which these observations are made, is the culmination of the preliminary or formative period which is required for the accurate calibration of the instruments used. As is often the case, the calibration period was three to four times as long as the observation time.

The measurements involved—of pressure, temperature and flow—are of particular interest and probably peculiar to turbine testing, because of the accuracies involved and the methods of calibration used. The accuracy of results is viewed not only with reference to the original calibrations and tests, but also in that they must be consistent, reproducible and reasonable. The results are also examined with reference to enthalpy or enthalpy changes in any steam path in the turbine. The importance of accuracy can best be realized when considering that the energy consumption of one large turbine is well above of one million dollars of fuel per annum.

Description of Turbine

The turbine test to be described was run on a reaction-type 1800-rpm. tandem compound turbogenerator rated at 115,000 kw. at 92% power factor. The normal steam conditions are:

Steam pressure at throttle, 640 lbs./in.^{2} abs.
Total temperature at throttle, 750°F.
Exhaust back pressure, 1" Hg absolute.

All the steam delivered to the throttle, except that used for feedwater heating in the final stage heater, is reheated to 750°F. There are four points of extraction for feedwater heating and the temperatures of the water from the final-stage heater at full load is 360°F.

The radial clearance between the rotating and stationary blades, as well as the clearance between the balance piston and the balance piston packing, is of particular importance in a reaction-type turbine. These clearances must be kept as small as possible in order to maintain efficiency at maximum. Measurement of these clearances must be accurate and their control positive. Normal running clearances are of the order of 0.025".

There are three phases in the turbine test. They are (1) the preliminary phase involving the calibration of instruments, training of personnel and setting up of test conditions, (2) the actual taking of data or the formal test period, and (3) the calculation of test results. This article deals in particular with the first two phases.

Description of Instruments

Pressures were measured as follows: above atmospheric by high-quality Bourdon type gages; below atmospheric by mercury manometers; atmospheric pressure by a good mercury barometer.

Temperature measurements were, in the main, taken with calibrated iron-constantan thermocouples connected to a potentiometer. A few temperatures were taken with mercury-in-glass thermometers.

The quantities of condensate, heater drain and boiler feed were measured by means of high-accuracy Venturi tubes with cadmium-plated throats, calibrated at an independent hydraulic laboratory.

Condenser leakage was determined by measurements of electrical conductivity.

The measurement of radial clearance (spindle position) was accomplished in two ways. The first was by physically measuring the axial difference in position of the rotating and stationary parts of the turbine; this being done at three different locations, one to determine "clearance" and the other two serving as operating indices. The second method involved the measurement of flow of steam through the balance piston to a point of lower pressure in the turbine. This flow measurement, converted into a differential pressure reading by means of proper connections to either a Pitot tube or an orifice, was used to calculate the clearance between the stationary and rotating parts of the balance piston — which measurement is directly related to the clearance in the turbine itself. (This measurement of clearance is the reverse of ordinary flow measurements, in that the area of the orifice was being calculated, rather than the known area of an orifice being used to measure the flow through it.) The measurement of the velocity pressure of the steam escaping through the balance piston labyrinth necessitated the design and construction of a special manometer (and therefore is worth a separate article). It is interesting to note that this "flow-clearance" measurement is used as an operating guide, both because it is very sensitive and because it is a continuous indication of the spindle position. In contrast, the actual axial measurements of spindle position are but spot or periodic readings.

Calibration of Instruments

1. *Pressure gages.* — All pressure gages were calibrated several times during the series of tests by means of a good dead-weight gage tester.

2. *Thermometers and Thermocouples.* —Thermometers were calibrated over their operating range against high-precision or "standard" thermometers in a

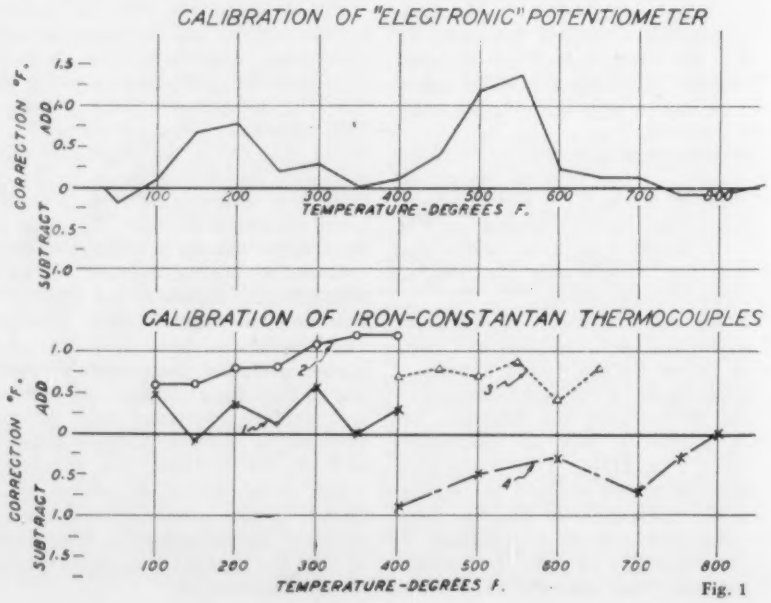

Fig. 1

*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

TABLE I—VENTURI TUBE MEASUREMENTS AND CORRECTIONS

Condensate	*Inlet*	*Throat*	*Correction Factor*
Original	9.970″	4.9975″	.....
Jan. '38	10.002″	5.002″	0.13%
May '38	9.981″	5.001″	0.15%
April '39	9.993″	5.001″	0.12%
March '46	9.979″	5.002″	0.18%
Boiler Feed			
Original	9.4145″	5.525″	.....
[illegible] 38	9.425″	5.534″	0.33%
March '46	9.420″	5.544″	0.77%

TABLE II—CONDENSATE VENTURI METER CALIBRATION

Flow lbs./hr. × 1000	Head in Feet of Water — Calibration	Test — Average	Test — Up	Test — Down
200	0.650	0.646	0.635	0.656
300	1.490	1.468	1.475	1.461
400	2.612	2.610	2.618	2.602
500	4.120	4.044	4.063	4.025
600	5.892	5.773	5.765	5.781
700	8.050	7.837	7.832	7.841
800	10.474	10.265	10.270	10.260
900	13.400	13.137	13.149	13.125
1000	16.366	16.412	16.506	16.318

correctly-devised and properly-operated constant-temperature bath.

Thermocouples were standardized over their operating range against two or more accurately calibrated "standard" thermocouples in a constant-temperature thermocouple testing tank by means of a precision potentiometer. All thermocouples were iron-constantan.

The thermometers and thermocouples were checked to an accuracy of ±0.1° to ±0.2°F and rechecks were made on some of both temperature-measuring devices after the series of test runs were completed to be certain that no drift occurred and that calibrations had been correct.

3. *"Electronic" Potentiometer.* — A push-button type of commercial "electronic" potentiometer was used to measure the various thermocouple temperatures. This potentiometer was calibrated over the operating range desired by the use of a precision laboratory potentiometer with the reference juntion in an ice bath. Several sets of data were taken in both directions: increasing and decreasing temperatures.

The results of the calibrations of the thermocouples and of the "electronic" potentiometer are shown in Fig. 1. Thermocouples were not necessarily constructed from the same spools of wire and results shown might be considered to be representative of the thermocouples tested.

The curve of the calibration of the "electronic" potentiometer represents the average of the readings taken in the "up" and "down" sequence of testing. The readings taken in the "up" series were consistently under those taken in the "down" series by approximately 0.2°F, with a maximum deviation of 0.4°F. The "sensitivity" of the instrument was set far enough below the maximum so that no hunting occurred. It is possible, on this particular instrument, to adust the "sensitivity control" so that the potentiometer will attempt to seek a balance between two turns of the coiled slidewire and will continuously traverse back and forth between these two points.

CALCULATION OF CORRECTION FACTOR

$$Q = K \times A_T \times \left[\frac{1}{1-(A_T/A_I)^2} \right]^{\frac{1}{2}}$$

where A_T is throat area;
and A_I is inlet area.

$$\frac{K_P - K_O}{K_O} \times 100 = \% \text{ correction}$$

where K_P is present constant;
and K_O is original constant.

4. *Flowmeters.*—The calibration of the flowmeters involved two separate functions. The first of these consisted in the inspection and cleaning of the Venturi tubes, followed by accurate remeasurements of inlet and throat diameters. Table I gives the measurements, taken over a period of years, of two Venturi tubes, the original measurements of which were made in 1929.

These two Venturis illustrate the extremes of erosion that have been found on this turbogenerator unit. The condensate Venturi, as far as change in throat diameter and visual observation of the cadmium-plated throat surface are concerned, has changed little over a period of some sixteen years. On the other hand, the boiler-feed Venturi, as indicated by both visual observation of the throat surface and by diameter measurement, has shown a definite and steady change: continued wear—a loss of metal equivalent to about 0.001″ in diameter per year—this change being fairly proportional to the length of service involved.

The apparent inconsistency in the measurements of the inlet diameter, particularly on the condensate Venturi tube, may be explained as follows: The inlet section of this tube was somewhat rough, particularly in contrast to the throat section, and accurate measurements were difficult to obtain. If we assume, for example, that this inlet diameter had remained constant at 9.970″, rather than changing as progressive measurements indicate, then the correction factor would amount to 0.20% in January 1938 rather than the 0.13% given; 0.19% for May '38 rather than 0.15%; 0.19% for April '39 instead of 0.12% and 0.20% rather than 0.18% for the March '46 tests. Thus, variations in inlet diameter do not appreciably affect the correction factor, for the maximum difference in diameter of 0.032″ represents a change of only 0.07% in correction factor.

Observation of the formula for the calculation of the correction factor shows why the measurement of the inlet diameter is relatively of little importance. The K is calculated for the original diameters and again for the present diameters and then the difference, divided by K_{orig}, represents the correction necessary to be applied. Increased diameters of the throat give a correction factor which means that the indicated flow must be multiplied by a factor in excess of 1.0. For example, the multiplying factor for the condensate Venturi as determined in March 1946 was 1.0018.

The purchase and installation of these high-accuracy cadmium-plated Venturi tubes has been entirely justified by their long, accurate performance.

The second function in the calibration of the flowmeters was that of the indicating instruments. This was accomplished by applying a measured head of water to the "high-pressure" side of the instrument and then reading the indicated flow. A water head, rather than a mercury head, was used because it could be more accurately

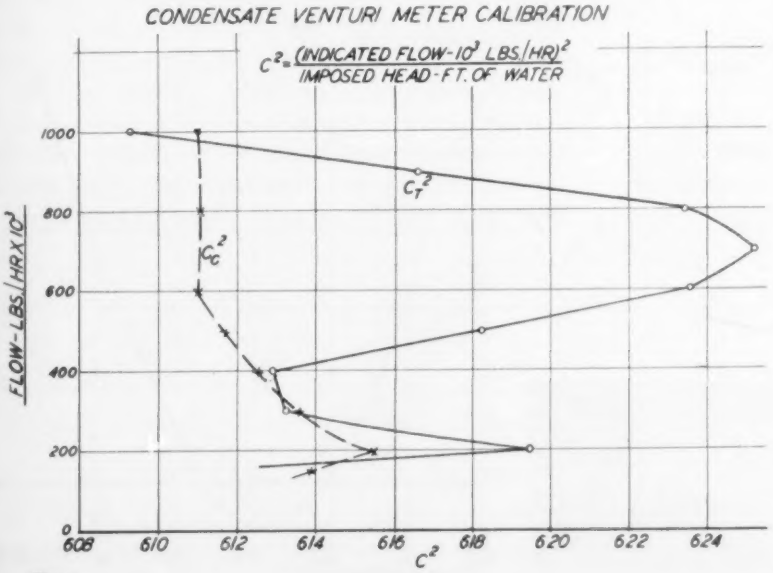

Fig. 2

read and results were more reproducible. Readings were made of the indicated flows when applying water head in increasing amount and then again in decreasing amount. Table II illustrates the readings taken on the condensate Venturi meter in March 1946. The original calibration head is also included in this table. In order to more readily compare the relationship of the meter as it was originally, and for the test under consideration, the indicated flow, in thousands of pounds per hour, was squared and divided by the imposed head in feet of water. This figure is denoted as C^2, and identified with the subscript C for the original calibration and subscript T for the present test. The C^2_C and C^2_T are plotted as shown in Fig. 2. The C^2_T at each flow rate is divided by the corresponding C^2_C, the square root taken and a plot made as shown in Fig. 3. This plot is that of the correction ratio for the meter at various flow rates and was applied as such in the calculations. This correction factor was necessary because of the wear. Observation of the figure shows that most of the wear occurs between flow rates of 500,000 and 900,000 pounds per hour and it is, of course, between these points that the meter operates a large portion of the time.

Now, a large number of instruments of various types have been properly calibrated and, because of the large number of calibrations made, the corrections must be viewed with the idea of reasonability of results. It often is easier to find errors by this type of observation than by other means and then to recalibrate wherever necessary. This same type of observation was also used for the many readings taken during the actual turbine tests; and errors in readings could be ascertained and corrected before they were too late to be reconciled with the other data.

Preparations for Turbine Test

Brief mention of other preparations for the turbine test, aside from the calibration of instruments, may further emphasize the care that is exercised.

A careful survey was made of all valves which, if leaking, would allow flow of condensate or steam from the turbine system (a loss not accounted for in the data taken), or which would permit the entrance of raw water into the turbine system. Feedwater heaters and evactor condensers were checked for leakage. Repairs were made wherever required.

The test was discussed in advance with the testing crew and they were instructed in reading the particular instruments with which they are concerned—"dry" runs being made to iron out possible sources of error. Emphasis was placed upon the accuracies of reading and recording data during the instruction and discussion period.

Arrangements for the actual turbine test were discussed with the supervisory operating force and all necessary arrangements were made. A list of the conditions of operation to be adhered to during the actual turbine test and a tentative chronological schedule of test was issued to all persons concerned. We have found that such a procedure greatly enhances the coördination and coöperation required to make a series of turbine tests proceed smoothly and accurately.

Test Personnel and Readings Taken

The actual test crew consisted of eight men, plus the services of a turbine operator and a switchboard operator, who took some test data in addition to their regular duties, and the efficiency engineer who observed conditions and checked with the various operating men and supervisors to see that conditions were being met and held as constant as possible. One member of the test crew acted as a roving liaison officer between the efficiency engineer and the test crew, checking readings and observing operation.

Pressure and temperature readings were taken at five-minute intervals during the one-hour test period. Readings of electrical data and of turbine clearances were taken at fifteen-minute intervals. Flowmeter readings were taken at half-minute intervals. In all, some 110 different instruments were read at various intervals during the one-hour test period, resulting in some 1760 readings. For the particular study involved, there were seven such one-hour tests.

The use of the push-button "electronic" potentiometer permitted taking approximately thirty readings every five minutes. The limitations in the number of readings which could be taken in this interval was not the rate of response of the temperature indicator but the rate of recording the temperature readings. The use of this instrument resulted in the reduction of the number of the test crew by two, as contrasted to former tests, and this was of particular importance to the war-reduced test staff.

We feel that the readings are as accurate as formerly taken.

Summary and Discussion of Results

A description has been given of the preparation for a turbine test, involving description and calibration of instruments, setting up of conditions and training of personnel. Some mention has been made of the data taken, frequency of observations and the amount of data taken.

The test results were calculated from the averaged data, in a manner following the A.S.M.E. Test Code, and expressed as turbine heat rate in *B*tu. per kwh. The heat chargeable to generation was plotted against turbine output and an equation for the heat rate curve was derived. In order to evaluate the test results to show the accuracy attained, it would be proper to have, at each particular load, two or more tests. Then, deviations from the average curve could be expressed directly as percentage plus or minus. Such a procedure has been followed on some of the acceptance tests but, since that time, we have become a little blasé about the necessity for so many tests. We can, however, show the accuracy of results when only a single test for each load is made. An equation can be calculated to average the set of tests and then deviations measured for each test point. Perhaps a more rigorous proof would be to equate only those points which provide minimum deviation from the curve and then measure the divergence of other points.

A graphic representation to show deviations from the average curve does not give the proper definition and, therefore, it seems simpler to state that, whichever method was used to calculate differences, those found were of the order of $\pm 0.8\%$.

Some mention was given earlier regarding the measurement of clearance between the rotating and stationary parts of the turbine. In this particular series of turbine tests, three individual

(*Concluded on Page 1158*)

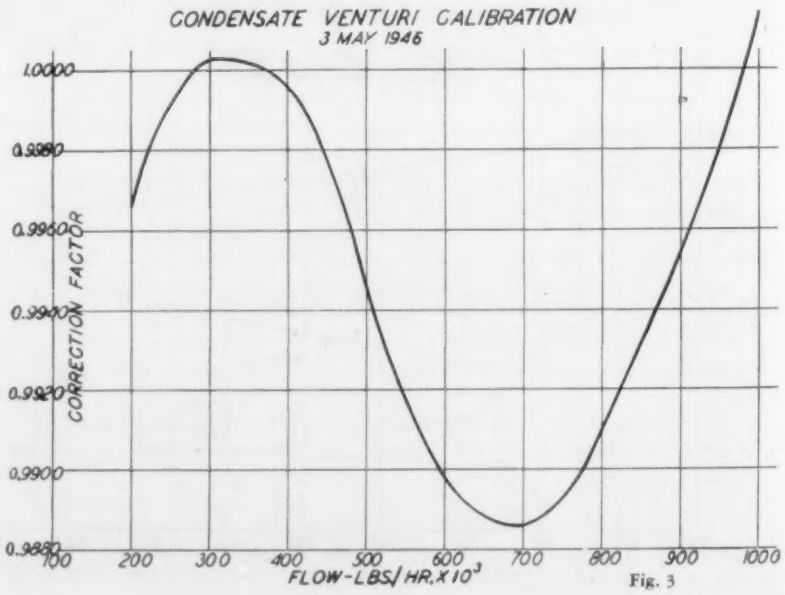

Fig. 3

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INSTRUMENTS ON THE MARCH

Transmissometer for Visibility Measurements

WASHINGTON, D. C.—According to Technical Report 1114 of the National Bureau of Standards, a new instrument called a transmissometer, developed at the Bureau for measuring atmospheric visibility, promises to be an important addition to airport safety equipment. Designed in the Bureau's Airport Lighting Laboratory to minimize the human factor in visual estimates of distance, particularly in foggy weather, it not only provides an indication of visual ranges but also seems readily adaptable for control of high-intensity airport approach lights, as well as control of fog-dispersal equipment.

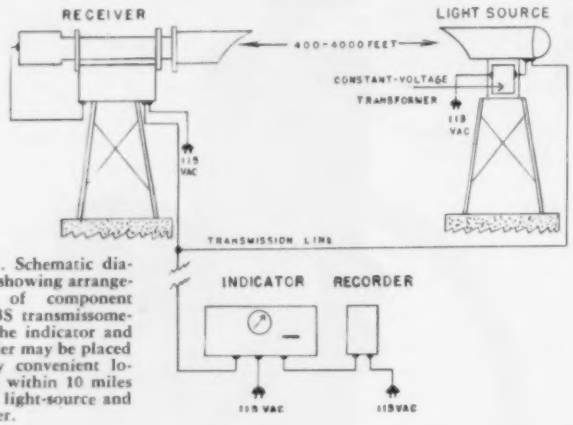

Fig. 1. Schematic diagram showing arrangement of component of NBS transmissometer. The indicator and recorder may be placed at any convenient location within 10 miles of the light-source and receiver.

Since visibility of objects or lights depends on transmission of light by the atmosphere, a correlation exists between the transmissometer readings and the maximum distance at which markers or lights can be seen by a trained observer. If the atmosphere is uniform, this distance can be determined directly from the readings, giving a quantitative description of visibility instead of qualitative terms such as "foggy", "hazy" and "clear."

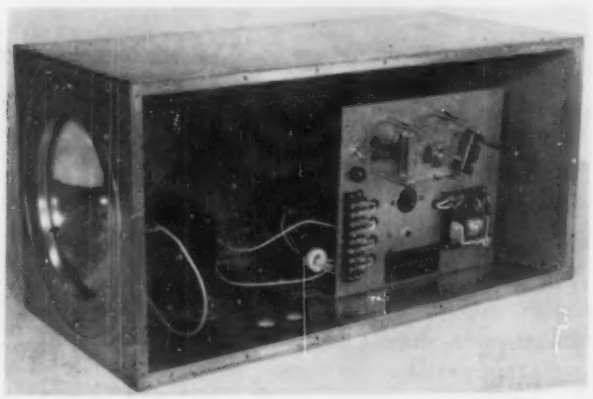

Fig. 2. Transmitter of NBS transmissometer.

The transmissometer consists of a light transmitter, a phototube receiver, an amplifier, and an indicator or recorder station (see Fig 1). The distance between transmitter and receiver depends on the particular application; distances up to 4000 feet have been used successfully in tests. The amount of light reaching the receiver from the transmitter, determined by fog density or other atmospheric conditions, is converted into a frequency proportional to the amount of light received.

A 6-volt sealed-reflector lamp constitutes the 350,000-cp. light source in the transmitter (Fig. 2). Its intensity is closely controlled by a voltage-regulating transformer and adjustments are made by means of a series rheostat. For a zero check the light is turned off automatically once an hour (see the hourly breaks in the records, Fig. 5). Intermediate zero checks may be made by the operator, who may be located several miles away.

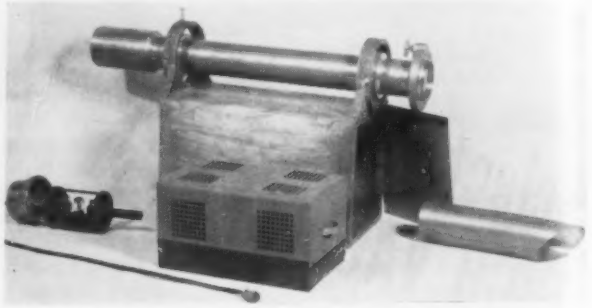

Fig. 3. NBS transmissometer receiver.

The receiver (Fig. 3) consists of a lens, a diaphragm, a photo-pulse unit and an amplifier. Light from the transmitter, focused by the lens on a "pinhole" in the diaphram, falls on the phototube receiver and generates pulses whose frequency is directly proportional to the intensity of light incident on the phototube. These pulses are amplified and transmitted over a signal line to the indicator. The frequency of these pulses may vary from 60 per second in clear weather to one in 20 minutes in dense fog.

The indicator consists of a two-stage amplifier, a frequency-measuring unit and a calibrator that provides a calibration frequency of 60 pulses per second. The two-stage amplifier amplifies and sharpens the incoming pulses and reduces the effects of noise picked up on the transmission line. The frequency meter levels and averages these pulses, and produces a meter reading which is directly proportional to the pulse frequency and thus to the transmission of the atmosphere between the light source and the receiver.

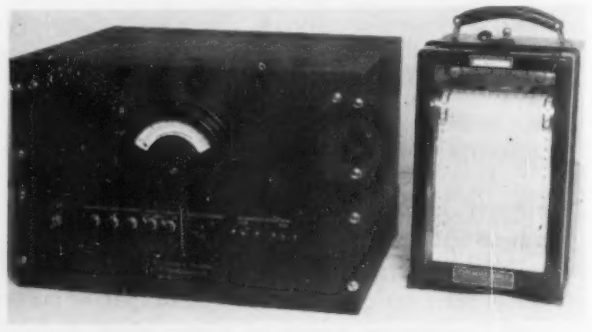

Fig. 4. Indicator unit of NBS transmissometer.

The indicator unit (Fig. 4) gives both a dial and a chart record. It can be placed as far as ten miles from the receiver. This allows installation of the indicator in the control tower and the use of more than one transmissometer to cover various parts of the airport with all indications centrally observed.

Investigations are now under way to determine exactly the transmissometer's scope and usefulness to aviation. Five units at the Joint Landing Aids Experiment Station, Arcata, Calif., are being used in study of fog dispersal methods and high-intensity approach lights. The instruments have also been in use at the CAA Experimental Station, Indianapolis; at the Naval Air Test Center for visibility and airport lighting equipment tests; and at the Tiffany Foundation (Long Island) under direction of the NDRC.

A special use of the instrument was indicated during tests

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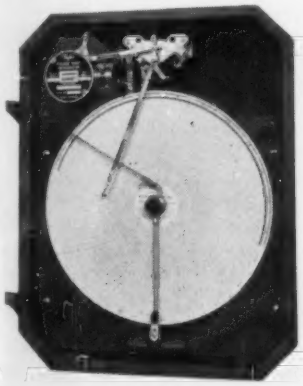

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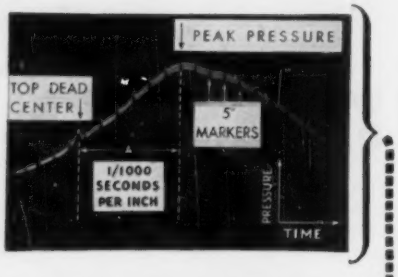

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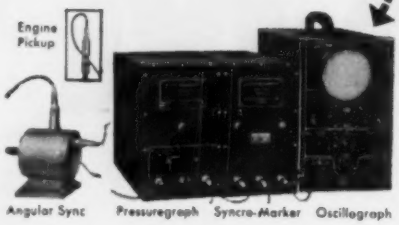

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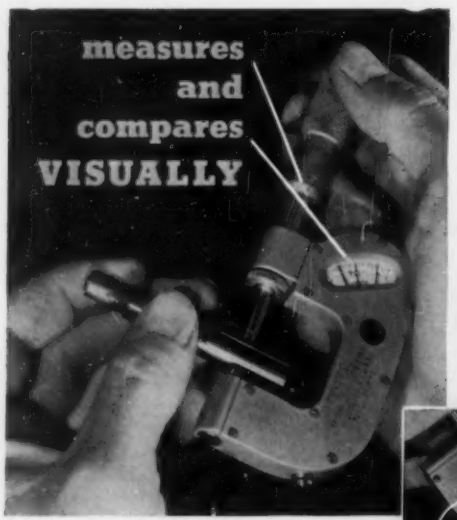

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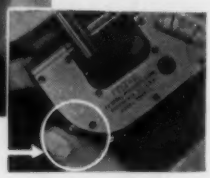

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at Arcata when it began to give evidence of the approach of fog *six hours* before any trace could be seen by the human eyes. Similarly, it frequently gives indications of the lifting of fog long before changes can be seen.

At present the principal applications of the transmissometer to aviation are: (1) as a control for high-intensity lighting and fog-dispersing equipment, (2) to supplement

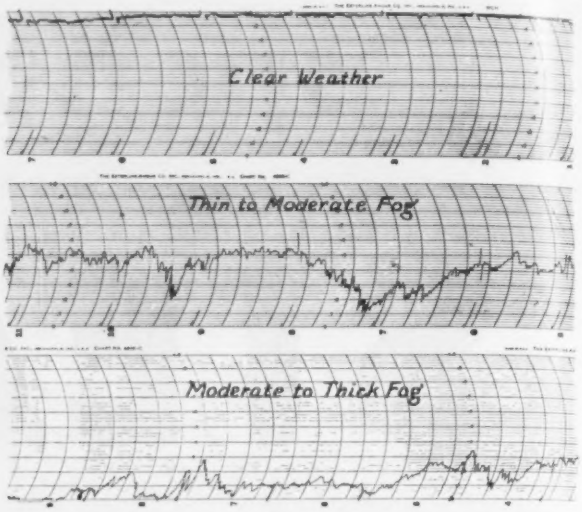

Fig. 5. Chart records from a transmissometer installed at the National Bureau of Standards. Transmissivity of the atmosphere in recorded (vertical scale) against time of day (figures along bottom of record chart).

periodic visual observations by a continuous record of atmospheric conditions, (3) to replace visual observations where trained observers or satisfactory marks, especially lights, are not available, (4) to provide a more accurate indication of visual ranges over a restricted area remote from the observer, particularly in an approach zone, (5) to record the variations and rate of change of conditions of visual range, and (6) to provide more accurate indications of the visual ranges when visibility becomes poor.

The instrument may have special applications at night when lights for visual estimations do not exist or cannot be used because they build up a confused light pattern as seen by an observer. In addition, it may also prove useful at automatic weather stations in remote unmanned locations where a continuous record of atmospheric conditions is desired.

Mass Spectrometry and Statistical Graphs in Gas Analysis

WASHINGTON, D. C.—According to Technical Report 1102 of the National Bureau of Standards, the mass spectrometer has shown remarkable usefulness in the analysis of gases and complex mixtures of gases. It offers an entirely new and different instrument for this type of analysis. It can in one operation resolve a complex mixture of gases in a few moments of instrument time—although subsequent computing may require hours or days, depending upon the complexity of the mixture and the method of computation employed.

The nearest approach to a real qualitative and quantitative system of gas analysis yet devised is offered by the mass spectrometer. Gas analysis is in some respects the most curious branch of analytical chemistry. No other kind of analysis of equal importance is so totally devoid of a definite system. When a mineral is analyzed, there is a qualitative system for discovering the elements and radicals present and a quantitative system for determining the amounts of each. But when a gas mixture is analyzed by the conventional volumetric chemical methods, the kinds of gas present are deduced from typical reactions which themselves are designed to disclose the amounts of these gases. In many cases the identifying reaction is not sufficiently specific to resolve

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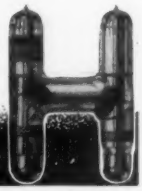

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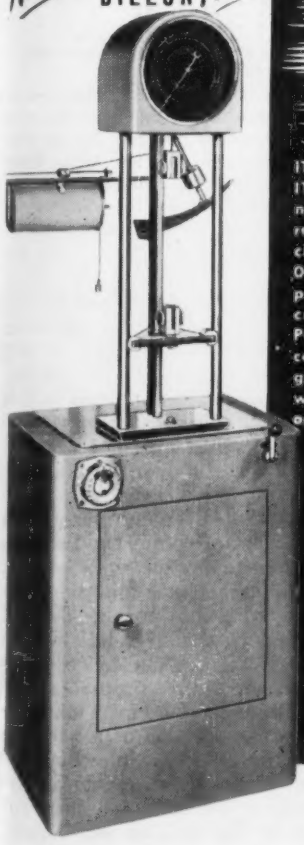

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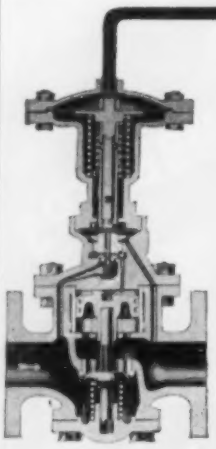

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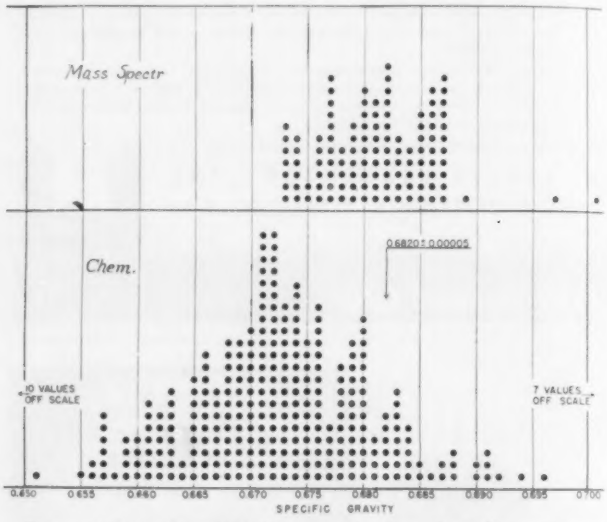
the mixture to its actual components. Thus combustion methods are incapable of identifying or estimating more than two hydrocarbons of a related series in any one sample.

The mass spectrometer separates various gases on the basis of the actual weight of the ions characteristically produced on dissociating each molecular species by electron bombardment. In many instances such a separation affords a clear-cut identification of each component of the mixture. Usually the quantitative resolution of the mixture may be achieved by the proper mathematical treatment of the spectrometer data; and often the qualitative and quantitative processes are simultaneously conducted as in the case of the older chemical methods.

Both the mass spectrometer and the conventional volumetric chemical methods have recently been used by a group of coöperating laboratories in the analysis of a standard sample of natural gas. Twenty laboratories possessing a total of 21 spectrometers participated in the spectrometric tests, and thirty laboratories in the chemical tests. This represents one phase of study of existing methods of gas analysis by means of a nation-wide coöperative analysis of standard samples, which the NBS is making in coöperation with a sub-committee of the ASTM. These samples are not to be



This typical plot illustrates the range of values of specific gravity—only one of several items in a complete analysis—obtained by two of the most important methods of gas analysis. The values in the upper section were calculated from analyses by the mass spectrometer and those in the lower section from chemical analyses. Every circle represents the specific gravity calculated from one analysis of the standard sample. The abscissas are numerical results derived from the analyses and the ordinates indicate the frequency with which they occur.

confused with the regular standard samples issued by the Bureau for purchase, but are carefully-prepared gas samples furnished to coöperating laboratories. Reports of this coöperative analysis *(RP 1759* and *RP 1789)* give for the first time a picture of the actual state of gas analysis in this country with respect to two of the three most important methods of analysis, the third method being fractional distillation.

All analytical data, together with the average values derived from each series of analyses, have been translated from extensive tabular form to a set of frequency-distribution plots which reveal at a glance the entire story both in general and in essential detail. Each circle appearing on the frequency-distribution plots represents a value derived from a single analysis. The circles are plotted equidistant on the ordinate corresponding to their value. Thus the abscissas are values derived from the analyses, and the ordinates indicate the frequency with which these values occur. This manner of plotting shows clearly the distribution of all the results and forms a basis of a probability curve, of which the maxima are the most probable values. These graphical pictures not only save hours of study of the tabulated data, but actually make the significance of the data so self-evident

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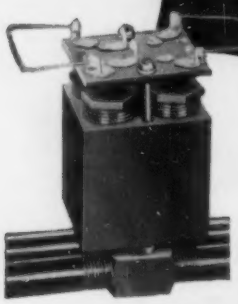

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that lengthy and detailed explanation of each plo[t] is [no]t necessary.

In general the results are scattered considerabl[y] mo[re] than had been expected. The lack of reproducibility betwe[en] laboratories clearly demonstrates for the first time the re[al] need for standardization of analytical methods and proc[e]dure in the field of gas analysis. Although the spectrom[e]ter values show better reproducibility and closer agreement wi[th] the known composition than do the chemical values, further improvement is believed possible. As the method is new a[nd] has not yet been subject to great variations of apparatus a[nd] procedure, efforts are being made to establish a standa[rd] procedure that will lead to even better results with the ma[ss] spectromcter.

Huge Tester for Airplane Wheels, Tires and Brakes

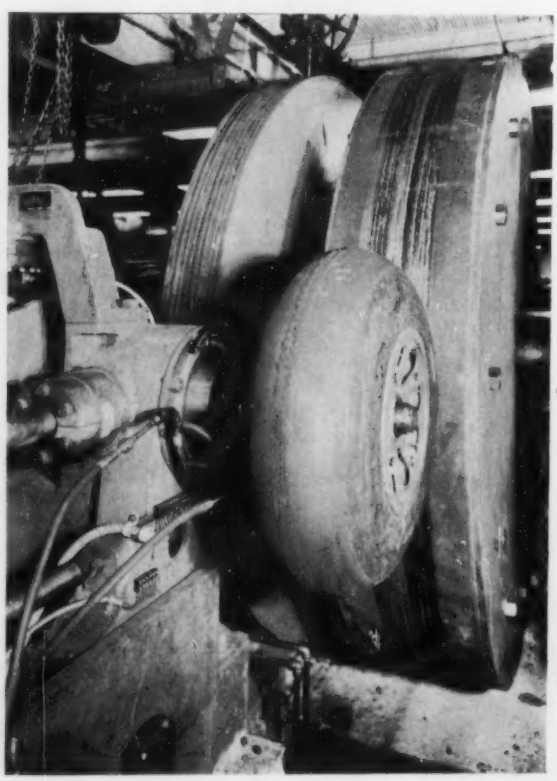
AKRON, Ohio.—Enough equivalent energy to lift a 1[0]-000-ton Liberty ship two and a half feet is built into a ne[w] machine for testing airplane wheels, tires and brakes whi[ch] the Goodyear Tire & Rubber Co. placed in operation re[-]cently. Goodyear officials announced that the machine ca[n] test landing loads up to 40,000 lbs. per wheel, tire or bra[ke] —the equivalent of an 80,000-lb. airplane.

Goodyear's new testing machine utilizes a wheel whi[ch] is 10 ft. in diameter and with a top speed equivalent to 2[00] m.p.h. By means of 21 plates distributed on both sides o[f] the center wheel, the dead weight can be increased or de[-]creased as desired.

Goodyear disclosed that the new testing machine has a[n] energy equivalent of 50,500,000 ft.-lbs., believed to be th[e] greatest energy capacity ever built into a testing device fo[r] airplane wheels, tires and brakes. The machine is powere[d] by a 150-hp. motor and needs only 17½ minutes to reac[h] top speed.

Requiring 168 revolutoins for the equivalent of a mile[-] travel after an airplane tire "lands" against it, the ma[in] testing wheel weighs between 16,000 and 17,000 lbs. Wit[h] the addition of the side plates, this weight can be increased to a total maximum of about 75,000 lbs.

Nine 1″ plates are provided on one side of the wheel an[d] ten 1″ plates on the other side. Both sides of the main test[-]



g wheel are equipped also with another half-inch plate hich weighs an additional 1475 lbs. each. Goodyear officials timated the weight of the entire installation at more than 0,000 lbs with the flywheel, its auxiliary plates ands its se accounting for 100,000 lbs. alone.

Requiring two years to build from the time of its conption, Goodyear's machine is equipped also to test airane brakes by direct connection to the axile of the huge wheel against which tires are "landed."

By harnessing a brake directly to the axle, a brake of fficient size to stop a 70,000-lb load can be tested.

In addition to the 40,000-lb. "landing" apparatus on one de of the flywheel, and the arrangement for testing brakes the flywheel's axle, the Goodyear testing machine is uipped also with additional tire-testing apparatus on the her side of the wheel from the "landing" device.

A feature of the installation is that power is applied to e flywheel from the 150-hp. motor by Goodyear's steel able V-belts, which utilze strands of woven steel in the rcass instead of conventional cords or fabric.

As the "landing" apparatus plunges a tire against the evolving flywheel, which simulates an airplane's landing peed, Goodyear engineers duplicate the performance of heels, tires or brakes as a warplane alights from the sky. he new Goodyear machine thus can duplicate landing peeds up to about 200 m.p.h., which is considerably in xcess of present landing speeds.

Giant Tire Undergoes Test on World's Largest Dynamometer

EAST PITTSBURGH, Penna.—The massive size of the orld's largest wheel, brake and tire testing machine used to mulate landing effect of future giant bombers, is shown with Michael R. Riola, aeronautical engineer of the Air Technial Service Command, examining the tire after a test run. he three-quarter-ton tire stops the 158-ton steel inertia heel in 20 seconds. The 110" tire is slammed against the teel wheel as the wheel speeds around at two miles a minte, simulating actual landing conditions without risking ersonnel or equipment. The apparatus, designed and built y the Adamson Machine Co. of Akron, O., in conjunction ith the Aircraft Laboratory, Engineering Division of the

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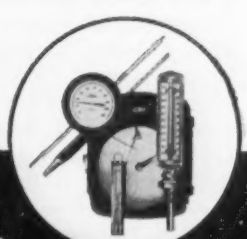

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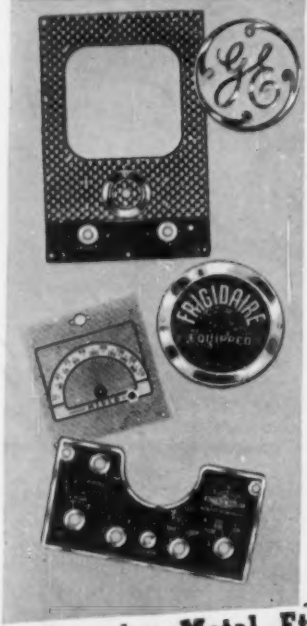

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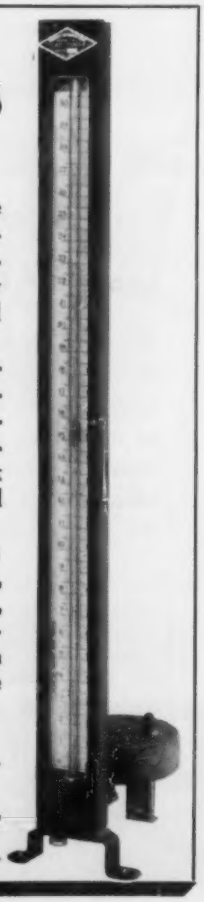

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37 W. Van Buren St., Chicago 5, Ill.

AAF Air Technical Service Command, is equipped with controls and motors built by the Westinghouse Electric Corporation. The dynamotor weighs 250 tons and with its AAF engineers at Wright Field, Dayton, Ohio, check the strength and operating characteristics of new airplane landing, wheel, brake and tire assemblies.

Teaching Scales the Right Weight

PHILADELPHIA.—Many of the county sealers in Ohio are figuratively from Missouri: it's hard to convince them their pet scales are anything but perfect. "But we can show

them," V. C. Campbell, Deputy Ohio State Sealer, said with a grin. "We have the equipment now to convince even the most skeptical."

That equipment is a mobile unit, housed in a C-70 Autocar. It comprises ten 1,000-lb. weights, a hoist, a dolly for moving the weights, and other minor equipment.

Operated by the Division of Weights and Measures of the Ohio Department of Agriculture, the unit will have blanketed the state by the end of this year. Industries served by the unit include coal and livestock yards, grain elevators, and other plants where huge scales are used to weigh trucks and trailers.

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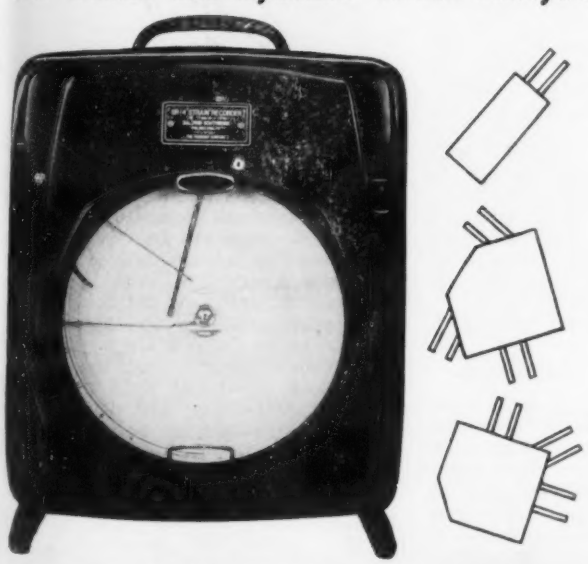
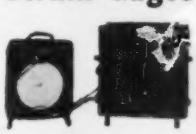


SR-4 RECORDERS and Strain Gages

SR-4 Recorders precisely and continuously indicate and record strain reported by SR-4 Strain Gages attached to machine or structure. Switching unit (right) successively scans up to 48 gage stations.



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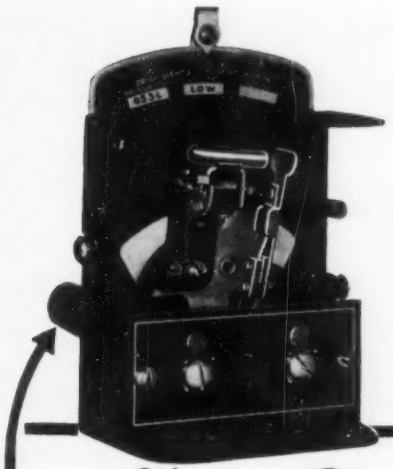
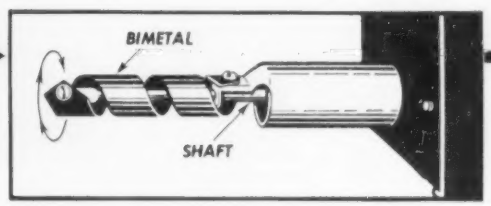
Offices: Philadelphia, New York, Boston, Birmingham, Houston, St. Louis, Chicago, Cleveland, San Francisco, Seattle, Washington, Pittsburgh.



"DETROIT"

Chace Bimetal in "DETROIT" IMMERSION CONTROL Keeps You in Hot Water



No. 10—Detroit Lubricator Co.

The "Detroit" No. 653 Immersion Control is designed for domestic hot-water boiler installations and is an excellent typical use of a Chace Thermostatic Bimetal Helix. It controls the burner regardless of thermostat demands and maintains a constant boiler water temperature, as set on the range adjustment scale.

The removable well is inserted in boiler wall below water line. As water enters, the outer end of helix moves counter-clockwise, turning the shaft of the contact arm. The permanent magnet causes a quick, snap closing of the contact points—and the burner is turned on. When the water reaches the set temperature, the reverse action occurs and contact is broken. Chace Thermostatic Bimetal provides accurate operation and long, dependable service as the actuating element in many such temperature responsive devices.

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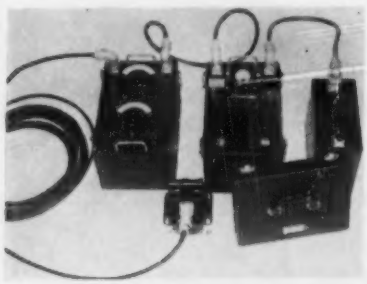
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1161

"One-side" Type Thickness Gage

New "Electroflux," for measuring corrosion and wall thickness from one side of metallic surfaces, is designed for non-destructive inspection and testing of metallic containers, vessels and piping while in service. It combines a 4-electrode probe, a small 6-volt battery,



an electronic voltmeter and power supply for measuring low-voltage output from the probe, and inter-connecting cables to permit probe to be moved about. It measures steel thicknesses from 0.125" to 2.250" within 3% of actual thickness. It weighs 55 lbs.—*Scott Electroflux Co., Waltham, Mass.*

Please mention number 1201 when filling out card

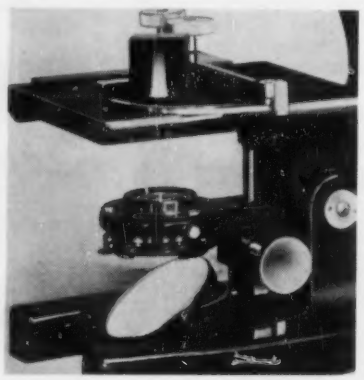
Mass Spectrometer

New "Model 21-201 Consolidated-Nier Isotope-ratio Mass Spectrometer" permits direct measurement of ratios of tracer isotope to naturally-occurring isotope in samples from different parts of a system under test. Among features are ease of operation; wide range (from hydrogen-denterium ratio to masses as high as 70); high accuracy (example, $< 1\%$ of ratio in C_{13}/C_{12}); two vacuum pumping systems; Alnico-produced magnetic field adjustable by iron shunts. Its principal application is biological research. — *Consolidated Engineering Corp., 620 North Lake Ave., Pasadena 4, Calif.*

Please mention number 1202 when filling out card

Microscope with Variable-focus Condenser

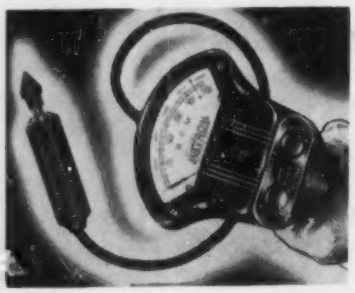
New microscope equipped with a variable-focus condenser provides for the first time full illumination in objectives having a focal length of 28mm. or more (intermediate and low-power magnifications). Its condenser achieves varying focal lengths equal to the focal lengths of all objectives. Almost instantaneous change in both magnification and illumination has now been obtained. Previously, this would have required a different condenser for each objective. New condenser cannot be fitted to old-type microscopes, but starting immediately, it will be standard equipment on maker's new laboratory microscopes without any increase in price.—*Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.*



Please mention number 1203 when filling out card

Electric Hand Tachometers

New triple-range electric hand tachometers for general-purpose speed measurements in rpm. or fpm. have an accuracy of 1%, 100-division 3⅛" scale. "Type 25A" has ranges of 200 to 2000, 500 to 5000 and 1000 to 10,000 rpm. "Type 25B" for low speeds has ranges of 20 to 200, 50 to 500 and 100 to 1000 rpm. Desired range is selected by switch and no damage results from selection of an improper range, changing ranges while in operation or over-speeding. Operating torque of the head is approx. 0.05 oz.-in. Speed adapters are available for extending speed ranges up or down by a factor of 10. Angle adapters are available also for measuring speed in cramped quarters.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*



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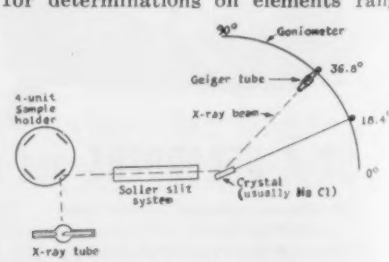
Fluorescence Unit for Metal Analysis

New Geiger-Counter Fluorescence Analysis Unit utilizes a new x-ray diffraction technique to make possible

rapid quantitative metal analysis. It determines quantitatively the purity of metals or the percentages of alloying components, also quantities of metallic elements dispersed in non-metallic carriers. Unit comprises an x-ray generator, a rotating indexing holder for four specimens, a special collimating system, a crystal (usually sodium chloride), a goniometer having a scale graduated from 0° to 90°, and a Geiger counter. Crystal and Geiger counter are mounted on and positioned by arms which traverse goniometer arc. Unit serves for determinations on elements ranging from atomic numbers 20 to 41 when a rock salt crystal is employed. For elements 42 to 50, a calcium fluoride crystal may be used. — *North American Philips Co., Inc., 100 East 42nd Street, New York 17, N. Y.*



Please mention number 1205 when filling out card

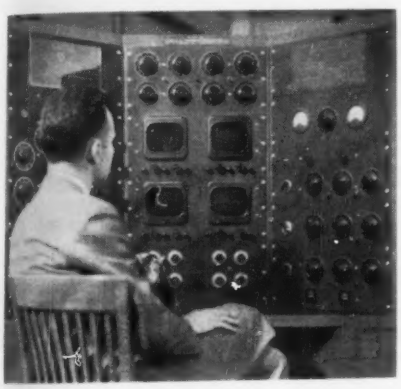
D-c. Power Supplies

New "HiVolt" hermetically-sealed high-voltage low-current d-c. power supplies transform 118-volt 60-cycle a.c. to 2400-volt d.c. "PS-1" is designed to charge "Plasticon" capacitors for use in photoflash and spectrographic analysis equipment; "PS-2" is intended for use in radiation counters, oscilloscopes, and television receivers. Both measure 3¾" × 3⅜" × 5½"; weigh 2¼ lbs.—*Condenser Products Co., 1375 N. Branch St., Chicago 22, Ill.*

Please mention number 1206 when filling out card

Electrical Analogs for Rapid Solution of Control Problems

New "Analauts" are commercially-available forms of "analogs" [see page 1101]. Illustrated is "Model 105", a console form of maker's "Automatic Analog Computor" designed and constructed for a special class of problems in control dynamics of vehicles. Transient recovery curves, following selected disturbances, are shown directly to operator, who adjusts parameters to find optimum conditions for stability and high performance. Complete solutions, in the form of design constants and criteria, may be carried out in short



order, even with dynamic systems for which analytic methods are prohibitively complex. — *George A. Philbrick Researchers, Inc., 230 Congress St., Boston 10, Mass.*

Please mention number 1207 when filling out card

Vacuum Thermocouples for Radiant-energy Measurement

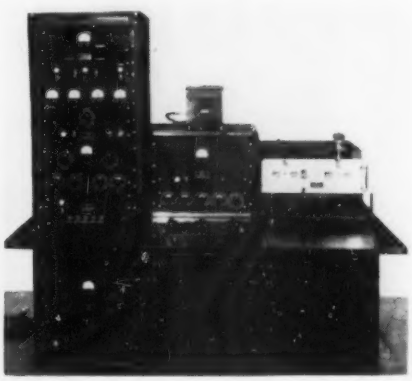
New "Type R" thermocouple has the following characteristics: (1) High sensitivity—developing 0.066 microvolts

with radiation intensity of 1μw/cm² at lamp color of 2785°K.; (2) short period, approx. 3 sec.; (3) resistance approx. 6.5 ohms; (4) target approx. 4 mm.²; (5) spectral range useful between approx. limits of 0.3 to 3 microns; (6) high-vacuum mounting assures stability and freedom from zero drift. Used with a millivoltmeter, new thermocouples are said to be exceptionally useful in indicating, controlling, or recording temperature. A valuable feature is their ability to measure temperature of moving objects on conveyors.—*Field Electrical Instrument Co., 109 East 184 St., New York 53, N. Y.*

Please mention number 1208 when filling out card

Mass Spectrometer

New "Model M60" mass spectrometer, especially designed for analysis of isotopic and complex gas mixtures in biochemical field, has optimal resolution in "biochemical" range up to mass 100. Variable magnetic field permits larger masses to be focussed with lower resolution. It is a 60° type instrument operated from a 115-volt 60-cycle a.c. line. Mass scanning is performed by manually varying accelerating voltage with

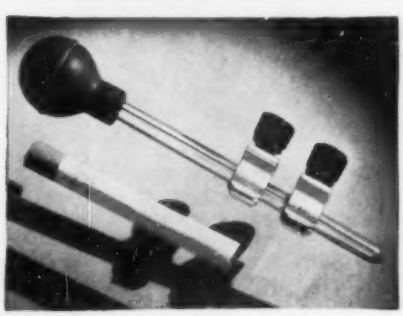


precision voltage divider. Ion beam intensity for each mass is measured by null method precision potentiometer. All parts of instrument are easily accessible. Tube is provided with ground joints at each end permitting easy access to source box and collector plate. A filament may be replaced in a few minutes. Electromagnet has fine adjustments for tilt, position, height and skew. Each electronic component is a separate unit, provided with its own fuse, power switch, pilot light and indicator. Line variations of 95-135 volts will not affect output.—*Process & Instruments, 60 Greenpoint Ave., Brooklyn 22, N. Y.*

Please mention number 1209 when filling out card

Pipette-type Conductance Cell

New "Type G-100 Micro Conductivity Cell," originally designed for study and checking of human-eye fluids, operates with only 0.05 to 0.10 cc. of solution.

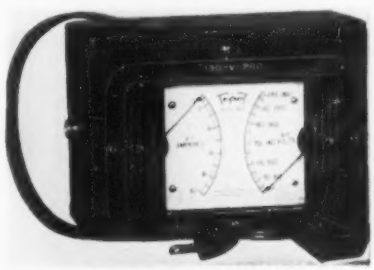


Cell constant is 100. Squeezing and releasing rubber bulb draws minute liquid sample up into thick-walled cell. Electrical connections are made by clip-on terminals snapped over external bands on glass tube.—*Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.*

Please mention number 1210 when filling out card

Appliance Testers

New "Models 2005 and 2006" Dual-instrument Appliance Testers are designed for those who prefer the voltmeter-ammeter method of testing household appliances and industrial applications. Full-range coverage provides simultaneous readings of line voltage and current drain. An indication of



power consumption may be obtained. Leather carrying case prevents scratching enameled appliance finishes. Weight: 2 lbs. "Model 2005" ranges: 0-10 a.c.-d.c. ammeter; 0-130-260 a.c.-d.c. voltmeter., "Model 2006" ranges: 0-25 a.c.-d.c. ammeter; 0-120-260 a.c.-d.c. voltmeter.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

Please mention number 1211 when filling out card

Colorside Projector

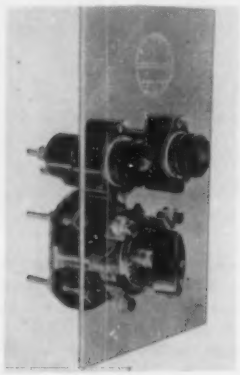
New "Spencer MK Delineascope" 2" × 2" colorslide projector is designed to provide greater screen brilliance and more even illumination from edge to edge than previous models, as well as coolness of operation and slide safety. It is available in 150-, 200- and 300-watt models with all surfaces of optical system hard-coated to assure maximum brilliance and image contrast. Other

features include a new 5" focus *f*/3.75 achromatically-corrected objective said to give needle-sharp definition; and a new slide carrier (Fig. 2) which automatically centers glass, cardboard or metal slides in focal plane. No refocusing is necessary once adjustment has been made. Company states projector's spiral focusing is rapid and precise and that an efficient heat-absorbinb glass (plus fan cooling in 300-watt model) assures slide safety. Carrying case opens from side and holds accessories and slides. — *American Optical Co., Southbridge, Mass.*

Please mention number 1212 when filling out card

Fused Rotary Snap Switch

New fused rotary snap switch saves space in switchboard installation. Assembly comprises "Type P" rotary



quick-make and quick-break, snap action switch in combination with panel-mounted fuse holders accommodating standard cartridge fuses in the 10-30-60-100-200-amp. ratings in which the switch is available. Fuse holder includes a neon-lamp type blown-fuse indicator and provides for replacing fuses from front of panel—*Electro Switch Corp., Weymouth, Mass.*

Please mention number 1213 when filling out card

Calculator for Sampling

New pocket-size calculator makes available to anyone the benefits of sequential sampling, is so simple that inexperienced operator may use it in connection with inspection of any production item. It tells operator how many samples to take, how long to continue sampling, and finally indicates whether the lot should be accepted or rejected. If a plant already uses sequential sampling, new calculator can be calibrated to fit existing standards, or a sequential sampling program may be developed by consultation with a quality-control statistician. Calculator functions on basis of five factors of quality control: (1) acceptable quality level; (2) unacceptable quality level; (3) factory risk; (4) customer risk; (5) average outgoing quality limit. Calculator can be supplied in metal or plastic, printed in three colors.—*Lightning Calculator Co., Inc., 496 Atlantic Ave., Brooklyn 17, N. Y.*

Please mention number 1214 when filling out card

Plug-in Scale-of-two Circuit

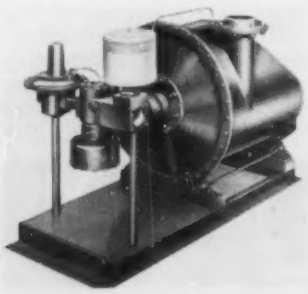
New "Duoscale" consists of a 6AL5 and a 6J6 tube in an improved Higginbotham circuit built in a 2"× 2" × 2" cast-aluminum housing mounted on a standard amphenol nine-prong tube-

base plug. All connections to other scaling circuits are made through the nine-prong plug. "Duoscale" can be used as a microsecond stopclock (using a crystal or tuning-fork oscillator and a series of scales as frequency dividers), for production-line counting and control equipment, and as a constant frequency divider in any process where events occur too rapidly to allow actuation of a mechanical register, By a procedure no more complicated than replacing a tube, a complete faulty scaling circuit can be replaced.—*Tracerlab, Inc., 55 Oliver St., Boston, Mass.*

Please mention number 1215 when filling out card

Gas-air Mixer

New Gas-Air Mixer is designed to pre-mix any commercial gas with air in any desired proportion and to deliver

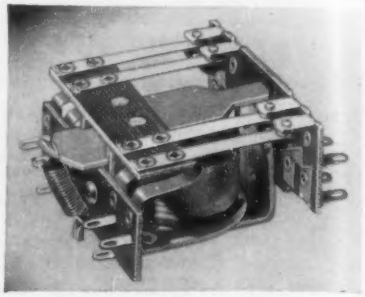


mixture to the burners under constant pressure. Mixture ratio is independent of fluctuations in gas pressure or changes in output demand; its control mechanism is located on air inlet side, obviating need for a stuffing box. Operator can check unit's performance by observing piston and valve operation through an inspection window. Five capacities from 3000 to 18,000 cfh.; discharge pressures range from 28 to 32 oz.—*Gas Appliance Service, Inc., 1211 Webster Ave., Chicago 14, Ill.*

Please mention number 1216 when filling out card

General-purpose Relay

New "Type C" multi-purpose relay can be quickly mounted on base or panel in any desired position, with terminals

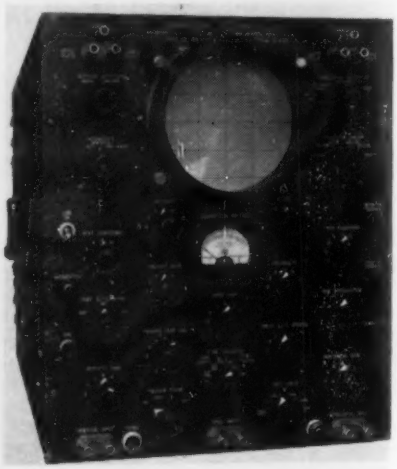


easily accessible; features a special Comar coil development said to provide dependable performance under all operating conditions. Average coil consumption, 7½ va. Contact current capacity, 5 amperes at 115 volts a.c. Any contact arrangement up to 4-p. d-t. Overall size, 2" × 2⅜" × 1¼". Weight 3 oz.—*Comar Electric Co., 2701 Belmont Ave., Chicago 18, Illinois.*

Please mention number 1217 when filling out card

General-purpose Oscilloscope

New "Model OL-15A" general purpose 5" oscilloscope is said to combine versatility of operation, dependability, minimum weight and bulk, and faithful presentation of high-harmonic-content waves. Among features: Response curve of vertical amplifier is linear and without positive slope from 10 cycle to 4 Mc. so that a 100-kc. square wave which rises or falls in the order of 500 volts per microsecond is faithfully reproduced. Horizontal amplifier response extends linearly from 10 cycles to 1 Mc. to accommodate any type of externally-generated sweep voltage. Sawtooth sweep range is from 5 cycles to 500 kc. with synchronizing sensitivity permitting synching and viewing 10-Mc. r-f. sine waves. Triggered sweeps of 0.2, 0.5, 1, 5, 20, and 200 microseconds per inch may be inaugurated by internal trigger generator or by external pulses.



Sweeps may be adjusted to occur before or after output triggers. Weight including self-contained power supply, 95 lbs. Dimensions, 15¾" × 12¾" × 19¾".—*Browning Laboratories, Inc., Winchester, Mass.*

Please mention number 1218 when filling out card

Frequency Meter

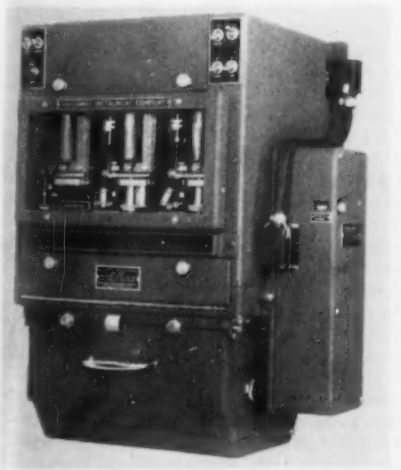
New "Model S-5" Frequency Meter is for checking transmitters operating between 30 and 500 Mc. A crystal

standard in a temperature-controlled oven is employed with a long time accuracy of 0.001%. Instrument is supplied hand-calibrated for one, two or three frequency bands in range from 30 to 500 Mc. with an overall accuracy of 0.0025%. Dimensions: 8¾" × 19" × 9"; weight, including cabinet: 35 lbs.—*Browning Laboratories, Inc., Winchester, Mass.*

Please mention number 1219 when filling out card

Twelve-element Oscillograph

New "Type RS-9 Automatic Oscillograph" is a twelve-element instrument specially designed to meet need of control-station engineer for automatic recording of unanticipated faults or for staged system testing. It will automatically record as many as 100 transients without attention, though they are seconds or months apart. Upon occurrence of a fault, it will start and reach full recording speed in 1/500 second (⅛ cycle on a 60-cycle system). Instrument can be supplied with built-in neutral current, over-current, and under-voltage starting relays. After initiation, it will record until fault is cleared: then stop automatically and reset in preparation for the next fault. Embodying twelve "Type OA-2 Galvanometers," it produces twelve records at once. These may be neutral current, phase currents and voltages, and power. A precision



optical system is said to assure fine-line traces and accurate records. Unit construction: "RS-9" can be furnished without starting relays and equipment for automatic operation when it is needed for manual or staged operation only; additional equipment for automatic operation can be purchased later and installed in a few minutes. Instrument is designed for portable or switchboard use.—*Hathaway Instrument Co., Co., 1315 S. Clarkson St., Denver 10, Colo.*

Please mention number 1220 when filling out card

Vacuum-tube Voltmeter

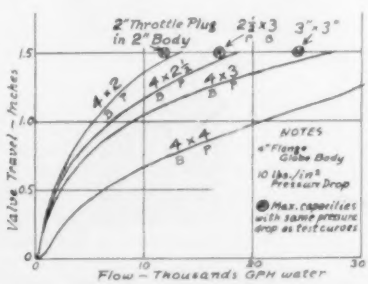
New "Type WV 65-A Battery Volt-Ohmyst" is a self-contained, lightweight vacuum-tube voltmeter which operates independently of any external power source. It can be used for servic-

ing radio and electronic equipment in automobiles, airplanes, boats, and industrial installations, and in rural areas or other places lacking conventional power outlets. Used with RCA Crystal Probe, it can be employed to measure voltages up to 100 Mc. Neon lamp on front panel flashes on and off whenever selector switch is in "+ voltage," "— voltage" or "ohms" position, indicating operation. Including batteries, new VTVM weighs 9 lbs. It measures 9½" × 6¼" × 5½".—*RCA Victor Div., Radio Corp. of America, Camden, N. J.*

Please mention number 1221 when filling out card

Interchangeable Inner Valves

New restricted inner valves for control valves are announced. Among advantageous applications: (1) Low-

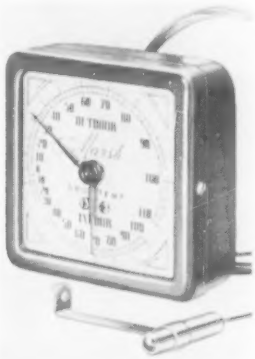


capacity requirements at time of original installation, but plans which anticipate need for increased flow through valve at a later date: by increasing size of inner valve in original valve body. (2) Occasionally valves with too great a capacity are installed with resultant "hunting" and poor control: corrected by installing restricted type inner valve in original oversized valve body. (3) In many installations, strength requirements demand a valve of full line size, but actually an inner valve one or more sizes smaller will pass required flow. Particularly true in power plants where line stresses may be high. When maker's reduced trim is used, valve port area may be changed by installing a new inner valve without changing seat rings. This makes for a high degree of flexibility in valve sizing.—*Fisher Governor Co., Marshalltown, Iowa.*

Please mention number 1222 when filling out card

Indoor & Outdoor Thermometer

New "Duo-Temp" is designed for house, apartment or private office. Top scale (see illustration) indicates 0-

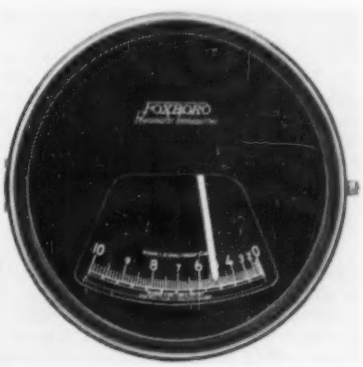


110°F. outdoor temperatures in black; bottom scale indicates 0-100°F. indoor temperatures in red. Instrument is enclosed in a highly-finished baked-enamel case. No glass to break.—*Jas. P. Marsh Corp., 2073 Southport Avenue, Chicago 14, Ill.*

Please mention number 1223 when filling out card

Pneumatic Transmitter

New "Model 42" pneumatic transmitter for process measurements such as flow, static or differential pressure, liquid level, temperature or humidity, is an indicator-type instrument, available with either an eccentric or concentric scale. It is an improved design of maker's previous model, most important change being completely new transmitting element which is exactly duplicated in receiving instrument. Improved accuracy in transmission is said to result from transmitting and receiving mechanisms being exactly matched and perfectly linear in cali-



bration. Simplified calibration is another feature of new design. Case is 12″ instead of 10″, which permits better location of instrument parts, facilitates field servicing, and provides room for additional units such as alarm or signal devices, when desired—*The Foxboro Co., Foxboro, Mass.*

Please mention number 1224 when filling out card

Tension Meter for Threads, Wires, etc.

New Tension Meter features trigger operation and automatic inserter for quick and precise checking of all tensions. It helps to select highest safe operating speed of machines so that threads, wires, yarns, etc., will not be stretched beyond danger point. It can be used also to measure tension in running paper strips, tinsel and other ribbonlike materials. — *Saxl Instrument Co., Harvard, Mass.*

Please mention number 1225 when filling out card

Variable Marker Oscillator

New "Mega-Marker," for laboratory use, is a precision variable marker oscillator. It covers range of 19 to 29 Mc.; for FM i-f. band (10.7 Mc.) a crystal oscillator is incorporated. Accuracy of 0.02 Mc. is said to be provided by more than 12 inches of calibrated scale length. Accurate check points are obtained through the employment of the crystal controlled oscillator.—*Kay Electric Co., 34 Marshall St., Newark, N. J.*

Please mention number 1226 when filling out card

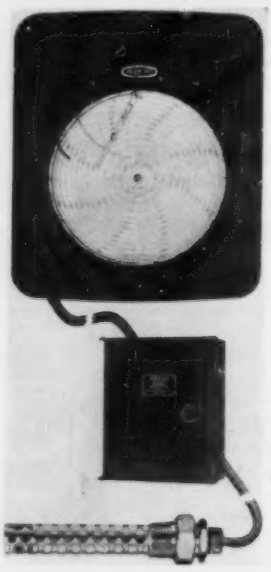
D-c. Amplifier

New "Microsen Amplifier" measures and amplifies inputs as low as 0.2 microvolts, utilizes a new principle of d-c. amplification which is claimed to make possible "a combination of sensitivity and stability heretofore impossible in a rugged and compact laboratory instrument." Input is amplified by means of an electro-mechanical balance, giving an output signal said to be directly proportional to input signal. Amplifier input circuit is insulated from output and ground. Input is measured and output stabilized through a feedback circuit. Mechanical zero adjustment has sufficient range to permit operation from various reference voltages. Instrument has adjustable gain, no lower frequency limit, and low input resistance. It is said that no extended warm-up period is required. Standard tubes to commercial tolerances are used, and no tube matching is required. —*Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn.*

Please mention number 1227 when filling out card

Dew-point Recorders and Controllers

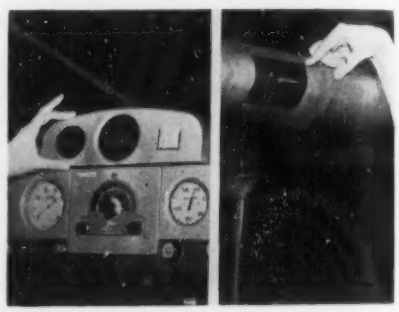
New "Dew Point Recorders and Recording Controllers," said to be the first simple, continuous dew-point measuring instruments available for industrial use, utilize new "Dewcel" measuring element. This comprises a perforated metal cylinder about 9″ long and 2″ diam., housing a central tube containing thermal bulb, wrapped with a saline-saturated woven glass tape and two windings of silver wire, to conduct heating current. Moisture determination by "Dewcel" is based on water-vapor pressure equilibrium temperature at which solution neither absorbs nor gives up moisture to atmosphere. Function of the variable heat supply is to bring "Dewcel" to this equilibrium temperature, which is measured by thermal bulb and read on chart in degrees of dew-point temperature. Recording is continuous. Various standard chart ranges are available, among them −20°F. to +92°F. dew-point and 36°F. to 160°F. dew-point. Two types of recorders are offered: "Dynalog all-electronic" and liquid-filled-system type, in round-form case. Pneumatic or electric control systems, for operating valves, dampers or motors, can be supplied in either instrument. Simplicity is claimed for new dew-point recorders, since they require no refrigeration, water supply, or air circulating system, and have no mirrors to be kept clean. They can be installed indoors or outdoors. Instrument can be mounted in a control panel as much as 600 feet from "Dewcel." Initial cost of instrument and installation is said to be much less than that of equipment involving compressors or pumps; and operating expense is negligible.—*The Foxboro Co., Foxboro, Mass.*



Please mention number 1228 when filling out card

Air-flow-switch-type Airplane Stall-warming Alarm

New "Safe Flight Stall Warning Indicator" consists of a wing unit and an instrument-panel unit. Wing unit consists of a small aluminum-alloy vane protruding outward from leading edge and actuating a low-force switch to open or close electric circuit to instrument. Installation requires a hole 1¾″ × 1⅜″ in leading edge. After unit is mounted, hole is closed by a cover plate with a small slit through which vane protrudes. Instrument unit flashes a red light and sounds a horn which can be heard above engine and prop noise. In normal flight, vane is held down both by air flow and by spring tension; and circuit is open. At critical speed, prior to and during stall, air flow raises vane, closing circuit. This prevents horn blowing at ALL speeds below stalling speed. Thus, on take-off or during landing, warning operates only for a second or two as plane passes through critical speed range. (This indicates to pilot that system is operative.) Instrument unit has been purposely designed so that it CANNOT be left shut off: if its operation were optional to pilot, serious consequences might result. (A special model, however, is being considered for training planes or charter ships which would incorporate a press-to-disconnect type switch. This would automatically become operative when pilot took his finger off button.) New system is designed to operate on 12-volt sup-



ply of personal aircraft. For a plane having no electrical supply, two 6-volt dry cells in series will provide "ample power for more than half a year," it is said. Installation is permissible by A&E mechanic, to whom company supplies templates which permit accurate placement of vane in leading edge. Recommended setting calls for warning to operate at a speed 5 mph. higher than normal stalling speed. Adjustment is possible. System is flight tested to operate at proper margin in level flight, after which it will operate with the same percentage of warning in steep turns or from any other position. Since instrument weighs less than 1 lb., no change in air plane's weight and balance statement is necessary. — *Safe Flight Instrument Corp., 21 Russell St., White Plains, N. Y.*

Please mention number 1229 when filling out card

Attenuator Terminal Board

New one-piece low-loss molded terminal board, insulation conforming to JAN specifications, incorporating insert type heavy-duty tinned brass lugs, adds to efficiency of attenuators. Possibility of terminals rotating is eliminated by new design.—*The Daven Co., 191 Central Ave., Newark, N. J.*

Please mention number 1230 when filling out card

Air-flow Switch for Cooling Systems

New "Flowswitch," originally designed for protection of forced-air-cooled electron tubes, consists of a small

vane which protrudes in airstream and actuates a sensitive precision switch. "Type A" is for mounting on round air-ducts, "Type B" on rectangular ducts. Switch contact arrangement is s-p. d-t. and rating is 5 amperes at 220 volts. Mechanical life expectancy, 300,000 operations. Housing dimensions 2½" × 1½" × 1¼"; clearance required for vane in duct, 2" or 3" depending on flow-rate of air and on desired actuating differential.—*Rotron Div., 180 Weeden St., Pawtucket, R. I.*

Please mention number 1230A when filling out card

Photoelectric Switch

New "Electronic Handyman" is said to take photoelectric switches, counters, gages and controls "out of the expensive class," is of "universal" design, plugs into any convenient outlet, accepts item-to-be-controlled plug at either of its normally-on or normally-off receptacles. It is said to have "many exclusive features": (1) combination layout and special circuits working on internally-converted d.c. provide fast switching operations for high-speed counting, limiting travel, etc.; (2) device will measure light intensity as well

as acting as a switch; (3) there is provision in housing for making it a combination counter or meter; (4) internal arrangement provides for filters for color or infrared operation; (5) 2" lens together with directional internal optics (5° arc) makes possible various gaging, measuring and controlling applications without use of a sensitivity adjustment. It is claimed that device "will operate in broad daylight on the light received from a small hand flashlight even though the "Handyman" be within 10° of facing directly into the sun."—*John T. O'Connor & Co., 217 South Valley Road, West Orange, N. J.*

Please mention number 1231 when filling out card

Turbidity Recorder

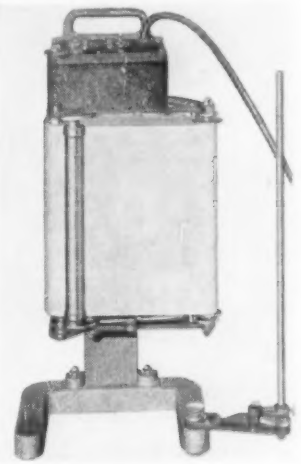
New "TR-6" turbidity recorder comprises a viewing chamber through which solution to be measured is passed, a light source attached to one end and a photo relay unit at other end. Output from photo relay unit is fed to a potentiometer recorder which

gives a continuous record of turbidity. Instrument may be equipped with warning lights or electrical control points. These instruments have heretofore been built only on special order and have been used to measure various undissolved substances or emulsions present in solutions; applications such as boiler feed water, water clarity, oils and solvents, and various fluids. New instrument is available in range of 0 to 3 p.p.m., 0 to 50 p.p.m., 100 p.p.m. and up. Length of chamber is a function of sensitivity and range required. Both open and closed type chambers are used. Generally, open type gives maximum cleaning facilities but solutions flowing in a pipe line may be measured by introducing a pipe tee with windows. Indicators, recorders and control units are available to meet many turbidity problems.—*Ess Instrument Co., 96 South Washington Ave., Bergenfield, N. J.*

Please mention number 1232 when filling out card

Kymograph

New "V-H" kymograph utilizes maker's continuous-feed principle; has following features: (1) May be used for vertical or horizontal recording; (2) While designed for 10" paper, it will feed narrower widths; (3) Eight speeds

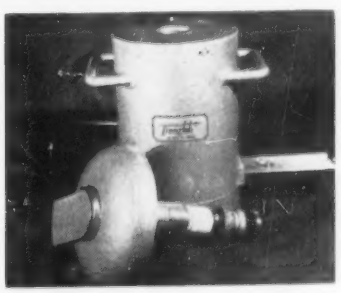


are provided: steps are in geometric progression, giving paper speeds from 2 to 450 cms/min. (4) Precision of paper movement is not affected by use or non use of take-up roll. Kymograph operates on 110-120 volt 60 cycle a.c. —*Phipps & Bird, Inc., Richmond, Va.*

Please mention number 1233 when filling out card

Sample Changer and Preamplifier

New "SC-9A" lead-shielded manual sample changer and preamplifier permits faster, more accurate counting of a large number of radioactive samples. It consists of a 2" lead shield, outside dimensions 11⅝" high × 6½" diam., to



lower background count by a factor of three to five. Upper section of shield holds a preamplifier circuit and a Tracerlab G-M tube; a stainless steel sample holder is mounted in a slide in lower portion. Samples can be loaded from either side. Sample holder is designed to take standard 1" diam. samples on planchets, filter paper, and in ashing dishes, as well as standard radioactivity reference sources. Geometrical reproducibility within 0.1% is attained. Ring and disk filter paper hold-

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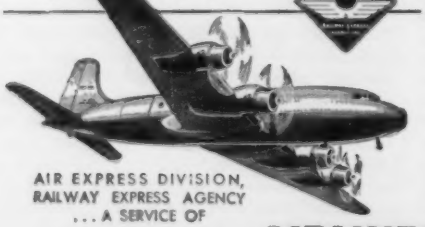

Fastest delivery — at low rates

Memphis, Tenn. manufacturer requested fast delivery of spare parts (34 lbs.) located in San Angelo, Tex. Picked up 11:50 AM the 21st, delivered same day at 5:40 PM. 668 miles, Air Express charge $7.31. Other weights, any distance, similarly inexpensive and fast.

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ers, planchets, Pyrex ashing dishes and radioactivity reference sources are available. Provision is also made for mounting calibrated foil absorbers between sample and G-M tube to determine energy level of radiation being measured and to lower detected count on samples whose activity is sufficiently high to introduce coincidence counting errors. A sample changer of similar design without a preamplifier is available for scalers not designed for use with a preamplifier.—*Tracerlab, Inc., 55 Oliver St., Boston, Mass.*

Please mention number 1234 when filling out card

Combustible Gas or Vapor Analyzer

New "Model 6 Supersensitive Vapotester" is a two-range instrument that "increases the sensitivity ten-fold." One

range analyzes combustible gases in terms of their lower explosive limit. A second scale indicates gases in their toxic range. Operating principle of previous "Vapotesters" is retained.—*Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.*

Please mention number 1235 when filling out card

Temperature-calibrated Potentiometers

New series of direct-reading temperature-calibrated portable potentiometers for use in laboratory, plant and

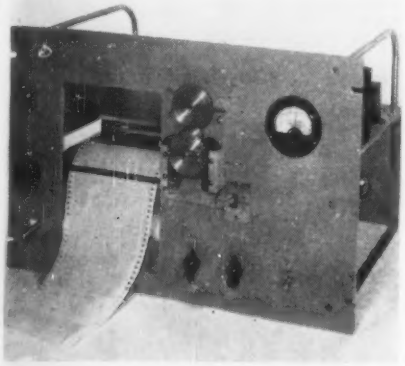
field, comprises ten standard models calibrated in °C. or °F. for use with copper-constantan, iron-constantan or chromel-alumel thermocouples. Special ranges can be supplied when required. Four models are listed with multiple-reflection "Pointerlite" galvanometers

said to afford substantial improvement in sensitivity over that previously available on low-temperature ranges. Accuracy in keeping with high sensitivity is said to be assured by special structural features which maintain reference-junction and automatic reference-junction compensator at substantially equal temperatures, irrespective of changes in ambient temperature. New units are suited for use in industries and laboratories where small temperature differentials are of interest. — *Rubicon Co., 3627 Ridge Ave., Philadelphia 32, Pa.*

Please mention number 1236 when filling out card

Frequency-response Recorder

New "Model FR-1" rack-mounted frequency response recorder has following features: (1) two motors, one for paper and one for pen drive; (2) one or

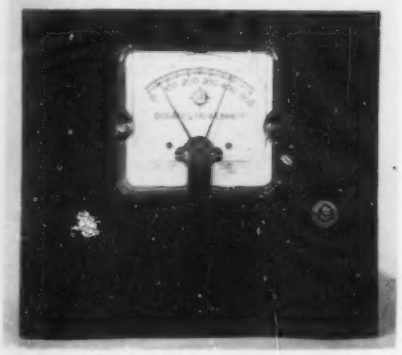


two paper speeds, as requested; (3) provision for mechanical linkage to oscillator; ready accessibility to input terminals; (4) sturdy construction; (5) easy serviceability.—*Sound Apparatus Co., 233 Broadway, New York 7, N. Y.*

Please mention number 1237 when filling out card

Electric-contact Type Temperature Controller

New "Simplytrol" temperature indicator-controller uses no electron tubes: contact-making indicator closes



a circuit directly to load control switch. Indicator measures 3¾" × 3⅜". Front is molded of unbreakable crystal clear plastic. High-resistance movements and 3" scales may be calibrated for all types of thermocouples and graduated in °F. or °C. Platinum contacts on indicating

HERE'S a rugged, portable, direct-reading, and yet accurate *field* instrument for measuring resistance down to .000001 ohm (1 microhm) that can be taken right to the job and operated by *one man* simply applying a pair of hand spikes and reading the position of a pointer over a scale.

The "Ducter" Ohmmeter is invaluable for detecting trouble in switches and circuit breakers . . . for measuring any type of low electrical resistance or contact such as armature and transformer windings, soldered joints, etc.

In one operation, the "Ducter" Ohmmeter performs what otherwise requires more complicated equipment as well as both training and practice in low resistance measurement. You'll find the story of this member of the famous "Megger"* family of resistance measuring instruments in your free copy of Bulletin 24-25-I.

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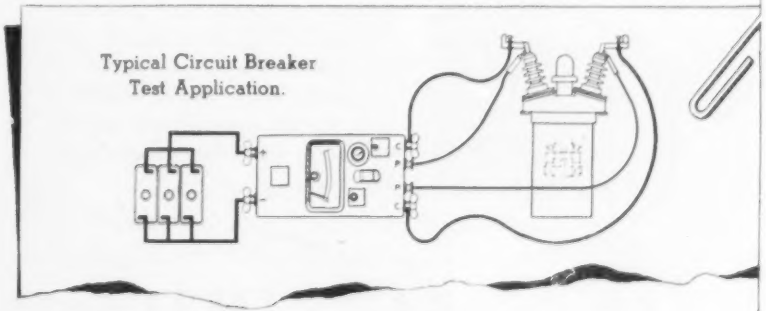

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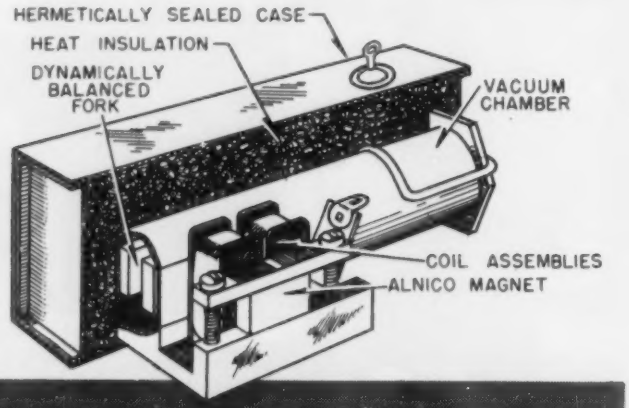
Temperature compensated fork sealed in a vacuum
NO OVEN NECESSARY!

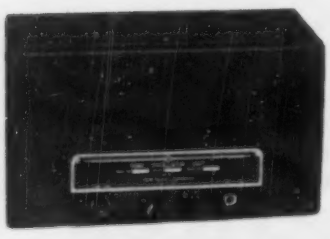


PRECISION STANDARD FORK OSCILLATOR
in a portable unit

Frequency Stability—one part in five million per degree Centigrade, from O° C. to +65° C.

Insensitive to changes in Barometic pressure, Humidity, and Line Voltage 90-130v. 50-70 cycles (when used with properly stabilized oscillator circuit).

Times Facsimile Corporation manufactures oscillator units for any specified frequency between 60 and 4,000 CPS.



Here's a Fork Oscillator designed and engineered by Times Facsimile Corporation with laboratory precision. Rugged, compact, portable, the oscillator is available as a separate unit or complete with power supply in a cabinet; or relay rack mounted. Price range $300-$500. Cabinet model shown here.

TIMES FACSIMILE
Corporation

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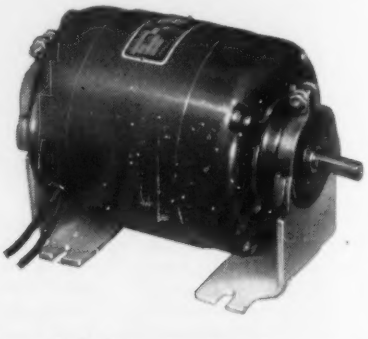
New York 18, N. Y.

pointer and setting arm are instantly locked together by an auxiliary circuit as soon as they touch; an automatic interrupter separates them when indicated temperature drops below set temperature. Load control switch, operated by closing of indicator contacts, is heavy-duty type with contacts rated at 10 amperes, 125 volts. Different contact ratings may be supplied. (For heavier loads a magnetic switch of suitable rating may be used.) Standard "Simplytrols" operate from 105 to 125 volts a-c. or d-c. (Other voltages can be accommodated.) Automatic-control feature may be cut out by flipping a switch whenever it is desired to bring a unit up to temperature and shut off heat and keep it off until reset by hand. Announcement emphasizes low price. Multi-range instruments are available at little extra cost.—*Assembly Products Inc., Main & Bell Sts., Chagrin Falls, Ohio.*

Please mention number 1238 when filling out card

Instrument Motor

New "Type U" split-phase motor is available in 1/20 and 1/15 hp. at 1725 rpm, and 1/30 hp. at 1125 rpm. Features include generous oil reservoirs around sleeve bearings, resilient mounting rings and thermal overload protection.—*Bodine Electric Co., 2264 West Ohio St., Chicago, Ill.*



Please mention number 1239 when filling out card

Traveling Recording Thermometers

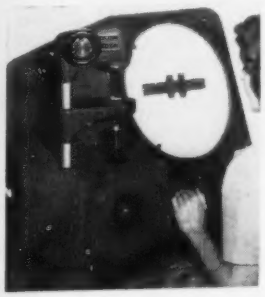
New model of traveling recorders, is said to embody a number of improvements. Instruments are designed for spray type pasteurizers but are equally adaptable to basket types. Cast bronze

water-proof case and thick plate glass front are large enough to allow reading entire chart record without removing cover. Bulbs are of stainless steel and bottle clamps are adjustable for various sizes of packages. Improved model retains such features as positive pen lifter; pen-arm bracket supported at both ends to eliminate back-lash and lost motion; positive micrometer pen adjustment; safety link for range protection; chart knob for easy removal; visible pen-arm with removable fountain pen. It is supplied complete with 100 9", 12-hour charts, in Réaumur, Fahrenheit or Centigrade scales and ranges.—*C. J. Tagliabue Div., Park & Nostrand Avenues, Brooklyn 5, N. Y.*

Please mention number 1240 when filling out card

Optical Comparator

New model of Wilder Projector and Optical Comparator is claimed to "fill a gap among the various projectors now on the market." Work stage and observation screen are close to each other, within operator's easy reach and line of vision, respectively. Vertical light beam and horizontal work stage provide most natural position for ma-



jority of work; protects operator against heat radiated by lamp. Additional comfort is provided by arm rest. Instrument when used for shadow images offers a choice of 6 magnifications: 10, 20, 31¼, 50, 62½, and 100×. Special surface illuminator is available as extra equipment for reflected images in 10 and 20× magnification. Screen diameter is 14½".—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*

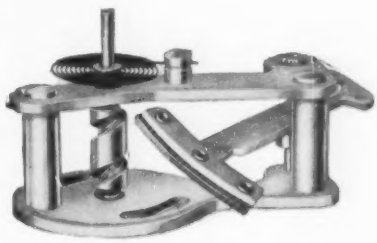
Please mention number 1241 when filling out card

Strain Indicator

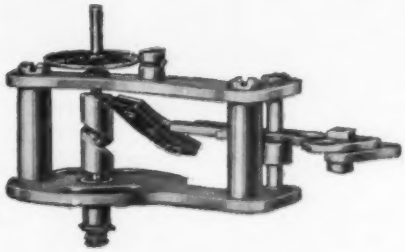
New "Model 5" Strain Indicator is a 10-channel version of larger "Model 2 A" fully described in August 1947

Do You Prefer A Right or Left Hander?

Helicoid Pressure Gages are made with either a right-hand movement or a left-hand movement—whichever is best for the service. Each movement offers an exclusive advantage not possible with any ordinary spur gear movement.



WITH THE RIGHT-HAND MOVEMENT, the cam releases from the roller just after the maximum dial pressure is reached. Thus, any over-pressure in the gage will do no harm whatever. Even the accuracy of the gage won't be affected provided the elastic limit of the Bourdon tube isn't exceeded.



WITH THE LEFT-HAND MOVEMENT, the cam releases from the roller just below the minimum dial graduation. Thus, any under-pressure, such as sudden vacuum, will do no harm whatever. The left-hand movement is ideal for hydraulic press gages or for sudden or violent pressure drops.

Only the Helicoid Movement has these advantages. And only Helicoid Gages have the Helicoid Movement.

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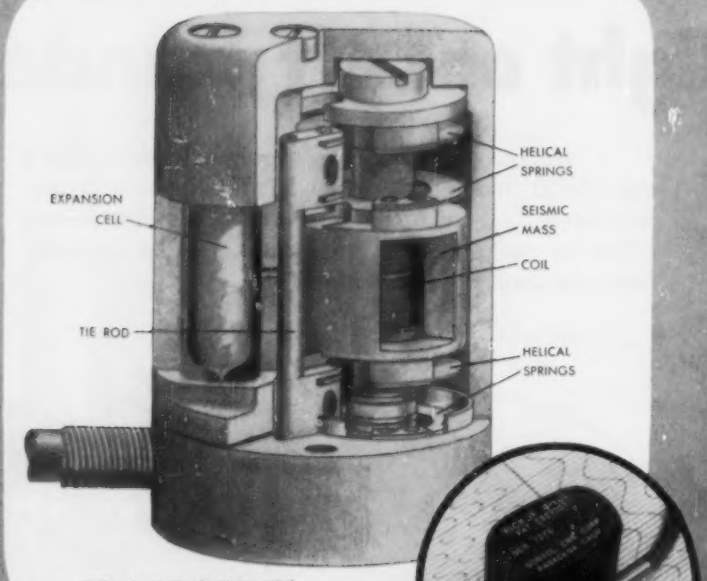
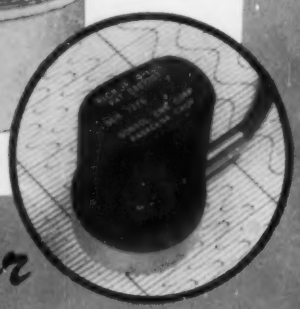
TRADE MARK

CONSOLIDATED VIBRATION PICKUPS



CUTAWAY VIEW (ACTUAL SIZE)



Your Answer to VIBRATION DETECTION PROBLEMS

WHETHER your vibration problem involves a giant locomotive, small electric motor, or other type of reciprocating or rotating machinery, or even a structure, the Consolidated 4-102 Vibration Pickup will serve you well as the sensing device.

This compact and rugged pickup, though simple in design, is a precision instrument that converts the mechanical vibrations to which it is subjected into electrical energy of comparable magnitude and wave form.

When used with suitable associated instruments, such as the Consolidated 1-110B Vibration Meter described below; the electrical output of the 4-102 may be converted, electrically, into terms of velocity, displacement, or acceleration, and then either indicated directly or permanently recorded, as you may desire.

Consult us concerning your particular problems, and we shall be pleased to advise you concerning the application of the 4-102 in their solution.

The CONSOLIDATED 1-110B VIBRATION METER is a compact, portable, self-contained instrument requiring no external accessories for operation other than a suitable vibration pickup, such as the 4-102. The 1-110B is a visual-indicating instrument for the measurement of vibratory displacement and velocity. The simple operation and compactness of this instrument make it indispensable for rapid vibration measurement.

For further information send for: Vibration Meter Bulletin CEC 1505-X2; Velocity Pickup Bulletin CEC 1507-X2.

Analytical Instruments for Science and Industry

CONSOLIDATED ENGINEERING CORPORATION

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Instruments, pages 752-754. It is a direct-reading instrument for measuring static strain, selectively, from as many as ten wire-strip strain gages. Strain (directly in strain units) is indicated immediately on an illuminated 7" scale. Compression is indicated to left and tension to right of zero center. Built-in power supply operates on 105 to 125 volts 60 cycle a.c. Metal cabinet is 10½" wide, 15⅛" high and 13½" deep, weighs approx. 60 lbs.—*Nosker Engineering Products, Yellow Springs, Ohio.*

Please mention number 1242 when filling out card

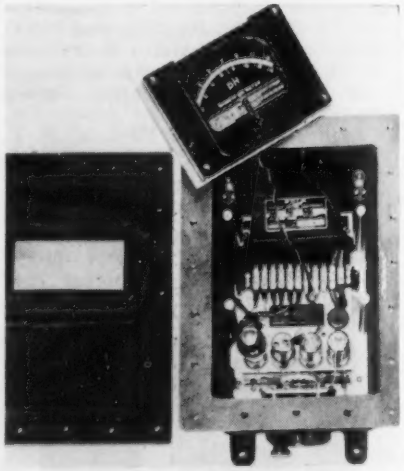
Air or Gas Dryer

New laboratory "Lectrodryer," of aluminum construction, is a portable unit capable of drying flows of gas or air up to approx. 100 ft³/hr. and will absorb about 5,500 grains of moisture before reactivation is necessary. Among applications, dehumidifying drying cabinets, supplying dry air for testing, supplying an atmosphere which will prevent moisture condensation on cooled materials, etc. Dew-points down to −60°C. and lower are readily obtained. To reactivate "Lectrodryer" after it has absorbed its capacity of moisture, plug cord into a 110-volt a-c. or d-c. light socket for two or three hours. New laboratory "Lectrodryer" operates on pressures as low as 2" of water; is built as standard for operation on pressures up to 15 lbs./in.².—*Pittsburgh Lectrodryer Corp., P. O. Box 1766, Pittsburgh, Pa.*

Please mention number 1243 when filling out card

Explosion-proof pH Meter

New explosion-proof line-operated direct-reading continuous-indicating pH meter is announced. It is designed in accordance with Class 1, Group D requirements for use in atmospheres con-



taining gasoline, petroleum, ethyl alcohol and acetone. New instrument is provided with a connection for operating a recorder at a remote position.—*The Macbeth Corporation, 227 West 17th Street, New York 11, N. Y.*

Please mention number 1244 when filling out card

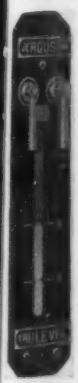
Large Stainless-steel Filters

New porous stainless-steel filter medium is available in large sheets as the result of a newly-developed butt-weld-

ing technique which makes it possible to join together 6" × 18" unit sheets of porous stainless steel to form large sheets of any required area. A modified form of "Heliarc" (inert-gas-shielded tungsten-arc welding) is used. New welding technique is particularly applicable in making up large sheets when filter material is 0.100" or more thick. Many types of special shapes can be welded from 1/16" thick material. Welds are strong and ductile.—*Micro Metallic Corp., 193 Bradford St. Brooklyn 7, N. Y.*

Please mention number 1245 when filling out card

Liquid-level Gage

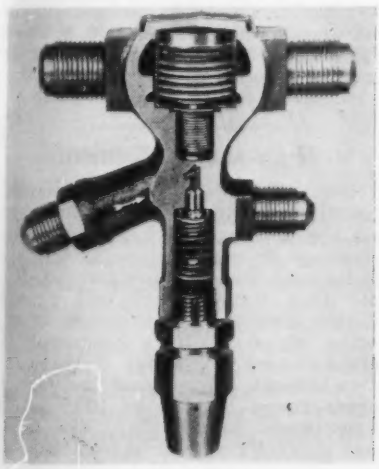


New "Trulevel Gage" is said to be the only boiler level gage which can be read and quickly checked at the remote reading point, by turning the two checking valve handles on cover "in a matter of only seconds." Correctness of remote reading and checking of boiler water level is assured by a new type of datum column located at the drum. This datum column is fully steam-jacketed, duplicating temperature and specific gravity conditions existing in boiler drum.—*Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.*

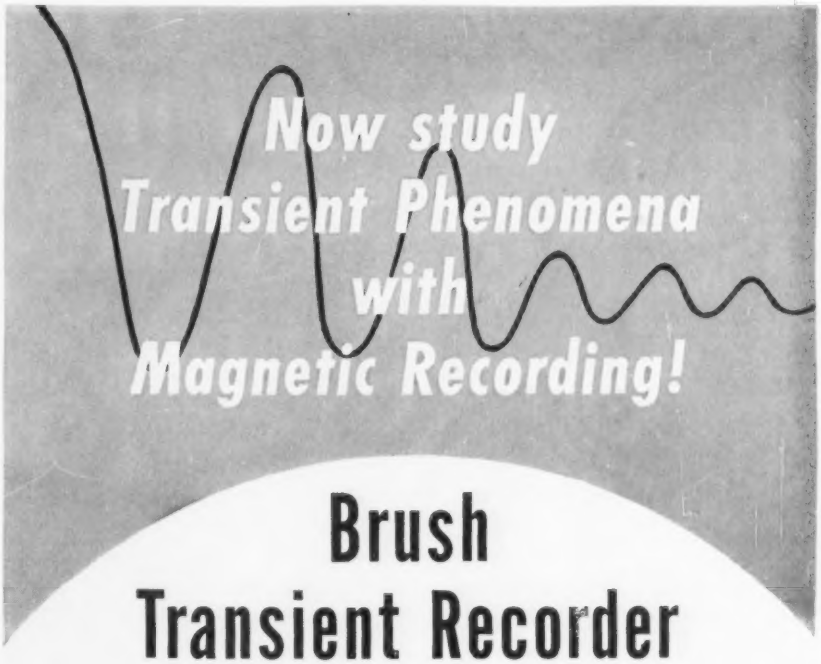
Please mention number 1246 when filling out card

Thermostatic Valve

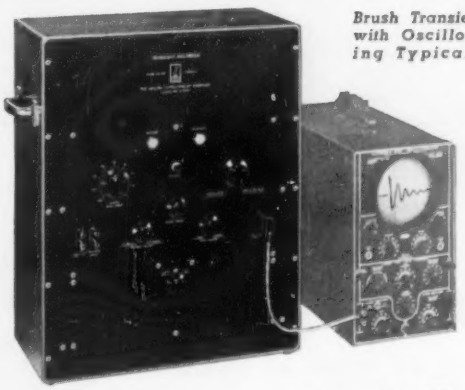
New thermostatic expansion valve for refrigeration applications has all connections in same place. (Maker's previous model was constructed with



suction and liquid connections at right angles to each other.) Neither size nor functional characteristics of valve have been changed. New model can be furnished with a check valve incorporated in regular size body. Check valve prevents back pressure and bleeding suction vapor from high-temperature evaporator to low-temperature evaporator when both are connected to one suction line; it enables one compressor to service two or more evaporators without hazard of temperatures becom-



Brush Transient Recorder



Brush Transient Recorder with Oscilloscope Showing Typical Transient

automatically records transient phenomena of less than 2/10 second duration—either electrical or capable of being picked up by electrical gauges.

Some typical phenomena which may be recorded by the Brush Transient Recorder include spot welding currents, light flashes, arc discharges, impact loads, etc. These results are accomplished by magnetically recording on a rapidly moving steel tape a frequency modulated carrier. Reset button clears tape and prepares it for re-use.

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ing equalized in evaporators during machine shut-down. Additional features include close maintenance of superheat control (as 5°F. superheat with ±0.5°F for control); considerable saving of space; and no appreciable time lag in control. New valve is claimed to be particularly adapted to modern evaporators with forced air, small tubes, short passes and distributor header combinations. — *Tenney Engineering, Inc., 26 Ave. B, Newark 5, N. J.*

Please mention number 1247 when filling out card

Frequency-distribution Graphic Instrument

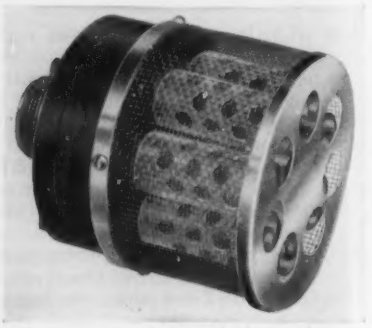
New combination curve, scale and square, made from a laminated transparent plastic, was developed by makers

for use in conjunction with their own statistical methods in quality control. It aids statisticians, inspectors, quality control engineers and others interested in analyzing frequency distribution of any product characteristic such as length, weight, diameter, strength, test values, etc. By following a set of instructions supplied with instrument, operator can quickly picture product distribution in scale relation to specified limits.—*Hunter Pressed Steel Co., Lansdale, Penna.*

Please mention number 1248 when filling out card

Hygrometric Element

New primary element for electrical-humidity measuring instruments utilizes the ability of a hygroscopic film to change its electrical resistance with microchanges in moisture content. It is said that this element will provide "highly accurate measurements over a period of years." It is guaranteed to retain an accuracy within ± 1½% relative humidity for at least one year. It covers range of 7% to 100% R. H. Dimensions: height 3½", dia. 3¼". New element responds in less than one



second to either decreasing or increasing R. H., detects changes as small as 0.1% R. H. When measuring, it neither adds nor removes moisture in significant amounts, even in sealed spaces. Its accuracy is unaffected by changes in barometric pressure. It may be used to indicate, control, and record. It incorporates a temperature-measuring element.—*American Instrument Company, Silver Spring, Md.*

Please mention number 1249 when filling out card

24-hr. Automatic Timer

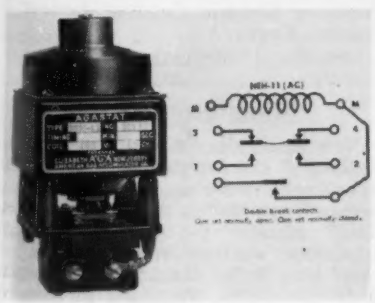
New "Palo Time Switch Sr." is for laboratory and industrial electrical apparatus requiring predetermined time schedules, operates on 110-volt ac. Among uses: automatic timing of

sterilizing, centrifuging, evaporating, etc. Self-starting clock has sweep second hand. 24-hour dial bears two adjustable switch fingers—for OFF and ON—which operate a snap-action switch. This, in turn, operates a relay of double-pole type, capable of breaking 20 amps. of non-inductive or heater load, also 1 hp. of motor load. Operating cycle repeats day after day, as long as clock is not disconnected.—*Palo-Myers, Inc., 81-83 Reade Street, New York 7, N. Y.*

Please mention number 1250 when filling out card

Electro-pneumatic Time Delay Relay

New "NEH-11" version of "Agastat" time delay relay incorporates all features of previous types plus a hold-in switch that makes possible remote push-button control. A normally-closed auxiliary switch affixed to bottom of terminal block acts as a hold-in switch. In de-energized state, switch contacts are held open by spindle. When coil is energized, spindle moves upward permitting contacts to close. Thus, when control energy is led through this switch, instrument is kept continuously



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The Counters can be installed at any distance from the switch or photo-electric unit where the count originates. Or, they can be mounted on panels in the Production Department and arranged so that a production supervisor can maintain up-to-the-instant counts of all operations throughout the entire plant.

You can also count on chewing gum to help employee's on-the-job efficiency. Chewing gum helps relieve tension—keeps the throat moist—and prevents "false thirst" yet leaves hands free for work. That's why more and more plant owners are making Wrigley's Spearmint Gum available to everyone.

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energized after push-button circuit has been broken. Hence, a time delay may be instituted and carried through to completion by push-button control. Only interruption of control circuit energy led through this switch will cause relay cycling to normal de-energized state. Restoration of power will not restore instrument to service. To accomplish this, the complete cycle instituted by push-button must be repeated. "Type 1"—Time delay starts when coil is energized (control circuit closed); "Type 2"—Time delay starts when coil is de-energized (control circuit opened).—*American Gas Accumulator Co., 1027 Newark Avenue, Elizabeth 3, N. J.*

Please mention number **1251** when filling out card

A-c. Power Supplies

New "Types UC1M and UC2M Voltbox" a-c. power supplies offer features of lightness and flexibility. Contained in

cast-aluminum case are a "Powerstat" variable transformer; a voltmeter, accurate to 2%; three output receptacles and a set of "Superior" binding posts; an ON-OFF switch and LINE-LOAD switch; renewable fuse; and 6-ft. cord-plug. Ratings: (1) Type UC1M: input: 115 volts, 50/60 cycles; output: 0-135 volts, 7.5 amps. 1000 va. (2) Type UC2M: 230 volts, 50/60 cycles; 0-270 volts, 3.0 amps. 810 va. For users who already have a "Powerstat," new "Voltbase" is available. It has all features of "Volt-

box" but a "Powerstat" and LINE-LOAD switch. Fig. 2 shows "Voltbase" without "Powerstat" and Fig. 3 shows "Voltbase" with "Powerstat" mounted.—*The Superior Electric Co., 630 Laurel St., Bristol, Conn.*

Please mention number **1252** when filling out card

Miniature Resistors

New small-size "Akra-Ohm Precision Resistors" are for miniature equipment where need is for small, close-tolerance units. "Type 136" is the smallest "Akra-Ohm" resistor yet produced; has a maximum wattage rating of 0.25; is $1\frac{5}{32}$" long × $\frac{3}{8}$" diam.; max. resistance is 150,000 ohms. Standard tolerance is

1%; closer tolerances can be furnished on special order, as can special impregnation for operation under highly humid conditions. "Akra-Ohm Types 137, 133, and 134" are 2-, 3-, and 4-section units with 2, 3 and 4 leads respectively and with 0.25 watts maximum load per section. Maximum resistance of 550,000 ohms is available in "Type 133." New resistors have 2" tinned copper wire leads from which they can be suspended. Windings are non-inductive and labels are formed of three layers of acetate.—*Shallcross Mfg. Co., Collingdale, Penna.*

Please mention number 1253 when filling out card

Fluorescent Lamp and Starter Tester

New Fluorescent Lamp and Starter Tester is designed to materially reduce cost of operating fluorescent lighting.

It prevents waste of good lamps and facilitates repair of defective circuits. Its operation is said to be simple.—*Compco Corp., 2251 W. St. Paul Ave., Chicago 47, Ill.*

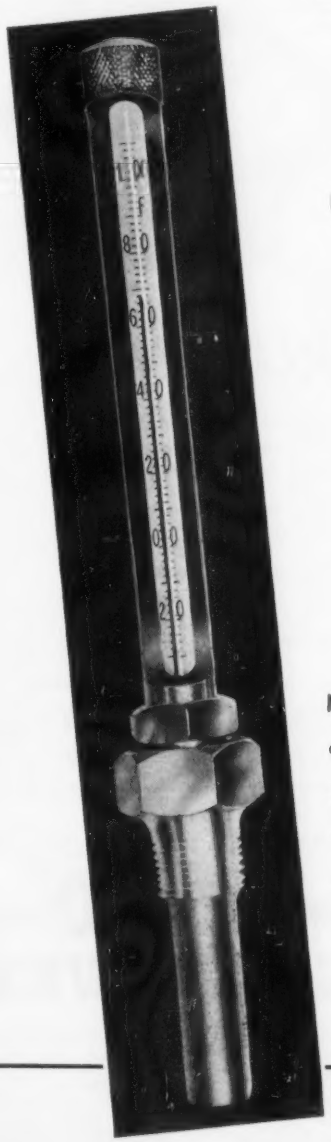
Please mention number 1254 when filling out card

Automatic Scaling Unit

New "Model 163" scaling device for use with Geiger-Müller counters incorporates facilities for predetermined

count and predetermined time operation, in addition to basic functions of older "Model 161." Scaling factors of 2, 16, 32, or 64 can be used when desired. New "Countomatic" switch allows selection of 10, 100, or 1000 times selected scaling factor for any predetermined count. The scaler will automatically shut off after this number, up to 64,000, and will indicate time required if connected to an electric timer. Scaler can also be used to count for a predetermined time, or for manual counting. Other features: self-contained high-voltage supply with close regulation; provision for oscilloscope connections; Higinbotham trigger circuits in scaling stages; interpolation lamps for deter-

ANOTHER NEW ASICO DEVELOPMENT



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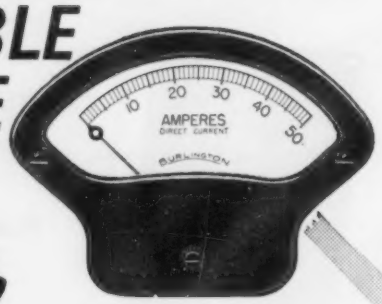

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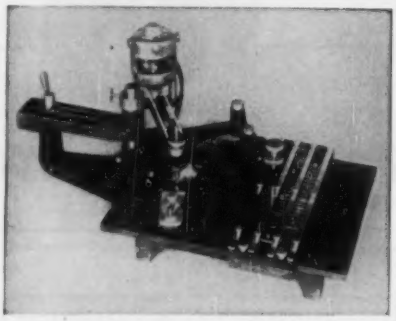

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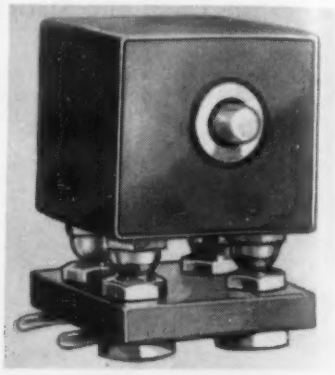
mining exact count; and an output stage that will drive built-in register 10 to 15 impulses per second.—*Instrument Development Labs., 222 West Erie St., Chicago 10, Ill.*

Please mention number 1255 when filling out card

Precision Switch

New "101"" quickly-renewable switch requires only 5-oz. pressure and ⅛" travel of actuating button (⅛" overtravel). It breaks both sides of the line; is non-snap type; has practically no differential; can be used to control 2 circuits, breaking one side of line of each. It can also be used as a sequence

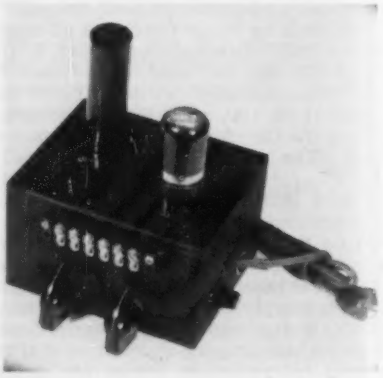


switch making one circuit before the other. It is designed for 10 amperes at 110-125 volts a-c. and under certain conditions is satisfactory at lower d-c. voltages and currents. Housing is plastic with a quick removable metal cover. Complete switch weighs 2 oz.; is 1 3/16" square; height with plastic mounting plate is 1¾". Travel plus overtravel (3/16") provide maximum cleaning action but 1/16" travel ordinarily suffices. Switch can also be furnished s-p. d-t. breaking both sides and d-p. d-t. breaking one side of each line.—*Congress Fan and Electric Co., P. O. Box 3747, Daytona Beach, Fla.*

Please mention number 1256 when filling out card

Adjustable-cycle Automatic Timer

New "Electronic Repeat Cycle Timer" is for process control as well as life testing and laboratory use, is said to have high stability and flexibility. Independently variable ON and OFF intervals ranging from 0.1 second to 4.0 minutes are available. Complete adjustability is provided. "Wide" variations in line voltage are said to have little effect (<1%) on timing intervals. Means are provided for synchronizing

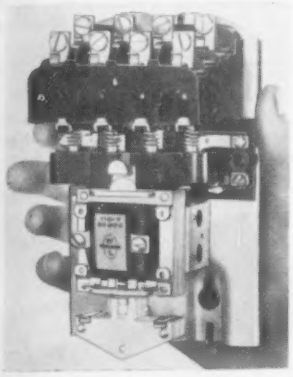


timer cycle with other equipment. Relay contacts having up to 2 transfers, d-p. d-t., each rated for 10 amperes at 115 volts a.c., can be provided. Case dimensions 3" × 4" × 5". Operation is from 115 volts, 60 cycles. Timers for operation from 115 volts d.c. can also be provided, if specified.—*G. C. Wilson & Co., 2 N. Passaic Ave., Chatham, N. J.*

Please mention number 1257 when filling out card

Solenoid Contactors

New "Bulletin 4451 Size 1" a-c. solenoid contactors are designed for use as main line, reversing or accelerating



contactors on a-c. motor controllers; also for remote control of heater loads and tungsten or infra-red lamp loads. Among features: Complete accessibility of all parts, high arc interruption capacity, simplified installation and inspection, and solid silver contacts silver-brazed directly to line and load connection terminals. Available with up to four main poles, new contactors have maximum ratings of 7½ h.p., 440-550 volts on 3-phase 60-cycle circuits. Standard operating coils are obtainable for 110, 220, 440 and 550-volts, 25, 50 and 60 cycles.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

Please mention number 1258 when filling out card

Portable pH Meter

New "Beckman Model H" portable glass electrode pH meter operates from 110-volt 50/60cycle a-c. line, weighs 14 lbs. and therefore can be easily transported. It covers full scale of 0 to 14 pH and can be used also for emf. readings within range 0 to ± 410 millivolts. Accuracy: 0.03 pH unit, and 2 millivolts. Standardization with one buffer is said to give accurate measurements over full range. Built-in temperature compensator dial calibrated

50 40 30 20 10 0 10 20 30 40 50

GALVANOMETERS

0 10 20 30 40 50 60 70 80 90 100

for detecting or measuring small values of current or voltage

High-sensitivity portable

Pointer type

General Electric galvanometers are available in two sizes of portable light-beam types, and for permanent installation. Applications include factory and laboratory testing in conjunction with bridges and potentiometers, and general measurement of low values of current and voltage.

The portable type is mounted in a polished walnut case with an internal optical system and light source to provide a high-intensity spot with a hairline for quick accurate reading. Extremely high sensitivities result from the multiple-reflecting optical system and the high-strength alnico magnets. The scale is marked both 50-0-50 and 0-100 in 1-mm divisions, and an external knob permits adjustment of the natural zero to either left or center scale. For greater adaptability, the moving-coil assembly is readily interchangeable so that many different sensitivities may be had in one instrument.

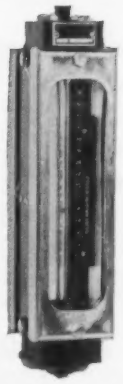
The pointer type is a sturdy, direct-reading, galvanometer of medium sensitivity, for permanent installation in specific applications. For further information contact your nearest G-E sales office or write for Bulletin GEA-2136D. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

602-114

The Full-View

ROTAMETER



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Why is the Full-View rotameter rapidly acquiring the reputation of being *"the accurate rotameter?"* Because every direct reading meter is individually calibrated for the conditions under which it will operate and fitted with a hand-cut flow scale. If you want accuracy, the way to get it is to specify "Full-View." For full information, write for Folder No. 20 to Brooks Rotameter Company, Box A-51247, Lansdale, Pa.

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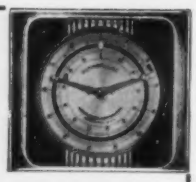

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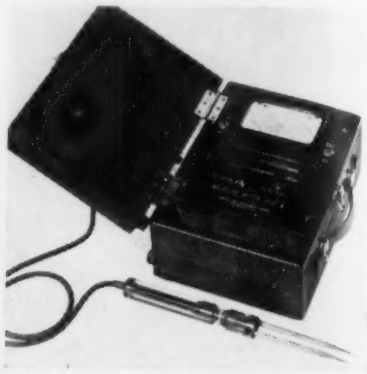
0 to 100°C. can be set at temperature of test sample. Changes in circuit constants, due to temperature effects, are approx. 0.1 pH unit in first hour and are negligible thereafter. Instrument may be checked and corrected for drift at any time by pressing a button on electrode terminal and bringing needle to pointer position with standardization control. "Model H" comes equipped with internally-shielded "Beckman Glass Electrodes." It measures 12" × 9½" × 8½" over-all, is supplied complete with electrode support rod, electrode holder, glass electrode, calomel electrode, pint of pH 7.00 concentrated buffer, 100-ml. saturated KCl solution and 50-ml. Pyrex beaker. — *National Technical Laboratories, 820 Mission St., South Pasadena, Calif.*

Please mention number 1259 when filling out card

Moisture Meter

New "% Moisture Meter" is battery-operated, utilizes electrical resistance method, indicates directly in percent moisture. It is calibrated by weighing material to be tested, and then measuring its electrical resistance with varying amounts of moisture until instrument range has been covered. Scale zero is based on resistance of material in oven-dry condition. Tests are made by pushing points of probe into material, or holding points against a surface with a steady pressure. Indications are immediate. Reproducibility compares favorably with oven testing. —*Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.*



Please mention number 1260 when filling out card

Flame-brillancy Combustion-control System

New method of controlling combustion in hog fuel-fired boilers by the brilliancy of the flame, furnace wall or fuel bed, has been developed. Hog fuel comes in many different forms, differs in size, Btu. content, moisture content, volatility, ignition temperature and burnability. New system utilizes a standard arrangement in that forced draft is controlled from steam pressure, induced draft is controlled from furnace draft, and fuel feed is controlled from steam flow; but differs in that fuel feed is readjusted by brilliancy instead of by steam flow-air flow ratio. Brilliancy is measured by a photovoltaic cell connected to a "Pyrotron" pyrometer. A steam flow meter, measuring boiler output, proportions fuel feed to steam flow by setting up an air loading pressure which operates fuel feed control

drive. Air loading pressure from steam flow meter is combined with air loading pressure set up by brilliancy meter in an air relay to form an average air loading pressure. This is transmitted to fuel feed control drive. If flame brightens owing to excess of combustion air, fuel feed is increased gradually until flame darkens to the required brilliancy. If flame darkens (deficiency of combustion air, or wet fuel fed to top of dry fuel), fuel feed is decreased.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

Please mention number 1261 when filling out card

Small Multi-purpose Relay

New "BO Power Relay" is said to be one of the smallest relays giving the greatest output." Results of tests in flight, firing and communication control equipment indicate that it has "excellent mechanical and electrical life." Designed for convenience of wiring, together with small mounting area, it is a multi-purpose relay, available for either a-c. or d-c. coil operation. Contact arrangement provides d-p. d-t. or double break with ¼" contacts rated at 15 amperes. Dimensions, $1\frac{13}{32}$" × $1\frac{3}{4}$" × $1\frac{7}{8}$". — *Allied Control Co., 2 East End Avenue, New York 21, N. Y.*

Please mention number 1262 when filling out card

High-speed D-c. Relay

New "Polarized Millisec" relay is a new model of "Millisec" relay illustrated and described in *Instruments*, Jan. 1946, page 60. It has an operating time as short as ⅓ millisecond. It is assembled in a standard metal radio tube container, but its operation is mechanical and not electronic. New "Polarized" model is a null-position double-contact polarized relay: only d.c. is used on the contacts; a.c. is not recommended. Contact rating is 110 volts d.c., ½ ampere.—*Stevens-Arnold, Inc., 22 Elkins Street, South Boston, Mass.*

Please mention number 1263 when filling out card

Molded Tubular Capacitors

New complete line of phenolic-molded paper tubular capacitors is announced. Units are highly heat- and moisture-resistant; are non-inflammable; are conservatively rated for operation from —40°C. to +85°C., and are mechanically rugged. In most instances, new molded tubulars are smaller (in no instance larger) than maker's paper tubular capacitors of equal rating. Available in 200, 400, 600, 1000 and 1600 volt types.—*Sprague Electric Co., North Adams, Mass.*

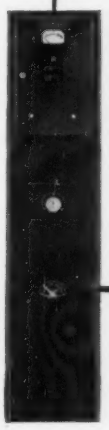
Please mention number 1264 when filling out card

Voltage-doubler Capacitor

New "Type T-121" television voltage doubler capacitor, with a dual 0.075 mfd capacitance and voltage rating of 7500 VDC, volts d.c., is equally well suited for precipitator, voltage doubler power supplies and photoflash equipment. Unit is built into a $3\frac{3}{4}$" × $4\frac{9}{16}$" × $5\frac{1}{2}$" rectangular container with over-all height of $8\frac{1}{2}$" to top of terminals. It is equipped with brackets for upright or inverted mounting. It is Dykanol-impregnated and filled; hermetic

Instrumentation News

3 POINT PROTECTION AGAINST FLAMMABLE GASES, VAPORS, VOLATILIZED SOLVENTS



The time to detect and indicate presence of combustible gases, vapors, volatilized solvents is before their danger point is reached—and that's just what the NEW and IMPROVED DAVIS GAS ALARM SYSTEM does. It not only detects the presence of these hazards but sounds an audible alarm at the low concentration point and/or shuts down equipment—giving time to put the hazard under control before it reaches the explosive range.

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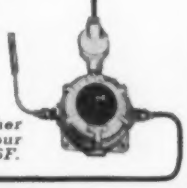

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1232

INSTRUMENT DEECO DIVISION

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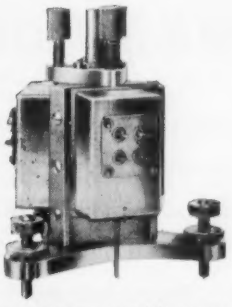

The Brewer-Statham Equilateral Fleximeter, when used in conjunction with an equilateral strain gage rosette, permits the determination of average stress and the stress on both sides of a plate from measurements made only on one side of the plate. Designers of structures with one side inaccessible, such as steam boilers, gas pressure storage vessels, and refrigerated cargo ships, will appreciate this new precision instrument. Write for full information.

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seal assures efficient operation under all atmospheric conditions; metallized glass terminals are solder-sealed with solder lug connections. New capacitor is also equipped with voltage divider discharge resistors. — *Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Please mention number 1265 when filling out card

Pointer Tubing Replacement Kit

New pointer tubing replacement kit is said to be "the answer to the instrument repair man's search." It is a complete kit of accurately drawn aluminum alloy pointer tubing made to exacting metallurgical specifications of this particular application. Kit contains 25 feet tubing available all in one size or a combination of sizes, in convenient lengths. — *Precision Tube Company, 3824 Terrace St., Philadelphia 28, Pa.*

Please mention number 1266 when filling out card

Photo-flash Capacitor

New "Type CR-101" cylindrical capacitor, designed for applications in portable photo-flash equipment, carries a rating of 10 mfd. 1500 volts d.c., weighs 1 lb., measures 2" diam. and 5" length; is equipped with two solder lug terminals insulated with laminated phenolic washers brought out at one end of metal housing. It is hermetically sealed.—*Cornell-Dubilier Electric Corporation, South Plainfield, N. J.*

Please mention number 1267 when filling out card

Vacuum Indicator-controller

New "Type DM Skanascope Vacuum Monitor" is designed for 1- to 200-micron range; signals by high-visibility luminous tube units connected

in series with a pair of gage tubes which, in turn, operate a relay (rated 3-amp. inductive load) for actuation of external apparatus. Gage tubes are of "G" type, their common exhaust connection arranged for optional metal-to-glass, rubber-to-glass, or direct glass weld sealing. Their calibration is fixed at factory to customer specification. Instrument will function with any two "Skanascope" tubes calibrated within 1- to 200-micron range; its components are electrically connected with octal type sockets and plugs; they may also be separated for panel mounting and other remote applications by use of SCM I remote cables.—*Skaneateles Mfg. Co., Inc., 12 Dickerson St., Syracuse 2, N. Y.*

Please mention number 1268 when filling out card

JOURNAL of the
Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.
I.S.A. National Office, 1117 Wolfendale St., Pittsburgh 12, Penna.

Vol. 2 December 1947 No. 12

Editorial

YOUR BOARD OF DIRECTORS

Article VI, Section 1 of the Constitution of the Instrument Society of America states that "The control and management of the affairs, property and funds of the Society shall be vested in the Board of Directors." Article IX, entitled "Board of Directors," states that (Section 1) each Section shall elect one member to the Board of Directors, (Section 3) each member of the Board of Directors, except ex-officio members only (the officers), shall have a voting power equal to the number of voting members in the Section he represents, and (Section 4) the term of office of the members of the Board of Directors, except ex-officio members only, shall be two years.

At the Board meeting in Chicago on September 6, 1947, a recommendation (among others) of the Constitution Committee was approved to the effect that the National Constitution should not specify the term of office of any Director (for reasons which are in part the subject of this editorial) and that the Constitution should be so amended.* The changes approved are that Section 1 of Article IX be changed to read "Each Section shall elect one member to the Board of Directors *and shall specify his term of office,*" that Section 4 (quoted above) be eliminated, and that Section 5 (not quoted herein) become Section 4.

It should be apparent to all that this change is highly desirable. In the first place it keeps the management of the affairs of the Society more completely in the hands of the Sections by removing a (perhaps academical) restriction on the Sections' rights in the matter of selecting their representatives. In the original article, although nothing specifically prohibited a Section from re-electing a good Director, no provision (or "out" for the Section) was made for removing an unsatisfactory one in case he wanted to contest his removal. His term of office was specified in the Constitution as "two years," a rule which could very well bring repercussions in years to come.

When the original article IX was written, it was proposed that half of the Sections elect one-year Directors and half two-year Directors. Those Sections electing one-year Directors would elect two-year Directors the next time so that the terms of office of the members of the Board would in the future be staggered. Thus a situation would never develop where an entirely new group of men, possibly all inexperienced, would assemble at a Board meeting and try to take up the running of the organization. This was the main reason for specifying the term of office of the Directors in the first accepted version of Article IX, Section I.

This is not to be construed as a criticism of the writers of the Constitution, nor of the first Board of Directors which approved it. Those men did a marvelous job, and it is a credit to their foresight that more changes have not been sought or made in the original manuscript. The few amendments proposed since ratification of the original Constitution have been deemed advisable as a result of the experiences of the Board in managing the Society during its first year and a half or so of life (our second birthday is January 10, 1948). The writer has attended most of the sessions of the Board at which these changes have been discussed, and we can assure our readers that such amendments are approved only after considerable pro and con discussion and only by the most democratic processes, and none have yet been approved which would, in our opinion, react to the detriment of our democratic system of Society management. In fact, all amendments to date have been necessary to make the Constitution more workable, and to in turn permit the unincumbered, yet controlled, growth of the Society and the expansion of its activities.

This brings up the point we wish to emphasize in this editorial — that the Director's post is a most responsible office, and should be given to the man of the highest caliber in each Section if the management of the Society is to remain in competent hands. In one sense, the Directors ARE the Society. They, as a group, elect the officers and hence the Executive Committee, disburse the funds of the Society, and otherwise exercise absolute control over all affairs of the Society. Each one is responsible only to his Section, and can be replaced on the Board only by action of his Section. It thus behooves each Section to elect as its representative on the Board a man of integrity, experience in Society affairs, and a deep interest in the Society and its welfare, as well as in his Section. In addition, he should be a man of sufficient responsibility that he can and will attend the regular and special meetings of the Board. In most Sections this also implies that he can be financially independent or have the financial backing of his company, since neither the Society nor most Sections (at least, at present) pay expenses of the Directors at these meetings. This latter situation sometimes makes a compromise necessary, but as the Society grows and its importance to industry is more completely recognized, more and more men with company backing will be available, and the choice of the best man will be made much easier.

Another important point is the instructing of the Director before he attends a meeting. Whenever a Board meeting is called, each Director is informed in advance what is to be on the agenda. It is his duty to inform the officers of his Section what matters are to be taken up at the Board meeting, and to arrange for a meeting of the Section Executive Committee at least, or perhaps the entire membership, at which matters can be discussed and the Director instructed as to the Section's preferences when the votes are taken. Some votes are taken by mail during the course of the year, and in such cases again the Director should have the backing of his Section, or at least of its officers, before casting his ballot.

A point which has heretofore received little attention is that each Director should be properly certified before being allowed to cast his vote at a meeting of a Board. Quoting from a recent letter from President Exline, "In the past there has been a certain laxity in the business relations between the Sections and the Executive Secretary's office . . . In particular, the vote of Directors has been accepted at meetings without formal certification having been filed with the Secretary. A case has come up in which a Section has repudiated the action of an individual accepted as the Director from that Section. In the future, voting cannot be accepted from any individual unless proper certification has been received by the Secretary . . . "

What constitutes proper certification? According to President Exline, the Executive Secretary (Dick Rimbach) is now preparing a form for certification which will be mailed to the Secretary of each Section. The signing of the form by the proper officials of the Section is in the future the only correct means of certification. This procedure should also be followed in the event a Director cannot attend a meeting and the Section desires to cast its vote by proxy. In case controversal subjects are to be voted upon, the Section's desires in each matter should be outlined in the proxy authorization. Otherwise the Section must depend upon the judgment of the man chosen to represent it. This points up again the necessity for electing a Director with care. If the proper man has been chosen, he will be able to attend all Board meetings and proxy voting will not be necessary. If circumstances *should* prevent a Director's attending, and an alternate is not sent and/or certified, the vote of the Section can be put in the hands of a capable proxy.

*ED. NOTE: In the past the word "Delegate" has been used almost exclusively in referring to the Board representative from each Section. Henceforth, however, we shall use in our writings the more descriptive and proper "Director," and shall campaign for the adoption of this term as a more dignified and fitting title for each man who serves on the *Board of Directors.*

With all this in mind, the Constitution Committee felt that the more men there were on the Board with experience in I.S.A. affairs, the more efficiently and wisely the Society would be run. When a Section finds a capable man to serve as its Director, neither the Society nor the Section that man represents should be deprived of his services because of a constitutional limitation on his term in office. Hence the change recommended at the last Board meeting. It is our personal hope that this amendment will be approved unanimously when it is submitted to the membership for a vote.

Just as the Director accepts the responsibility for his Section at Board meetings, the Section must also accept the responsibility of seeing that its Director is the best man obtainable. Here is where experience counts. An inexperienced or irresponsible Director can create considerable confusion and waste valuable time in a Board meeting. So, while the choice of a Director is entirely up to the individual Section, it is not amiss to recapitulate here some of the qualifications which should be considered in that choice:

1. He must be a man of experience in I.S.A. or other Society affairs. (An officer or former officer will most likely fill this requirement. A working knowledge of Roberts' Rules of Order is also a tremendous asset.)

2. He must be a diplomat. ("Personalities" should be kept out of Board meetings in-so-far as possible.)

3. He must have the interests of the Society, as well as of his Section, at heart, and use his voting power wisely —not selfishly.)

4. He must have the confidence of his Section and its officers, so that when he uses his own judgment in a vote, his action will not be subject to criticism "back home."

5. He must have the time and financial backing when necessary to enable him to attend meetings, and the time (or stenographic assistance) to promptly handle the correspondence by which the National Office keeps in contact with his and other Sections.

We should like to point out in conclusion that this editorial should not be interpreted as a criticism of, nor a reflection upon, any present or past Director. The growth and success of the I.S.A. during its formative years bespeaks the good intent and honest efforts of the men who have thus served during that time. As the Society grows, however, and the inevitable "growing pains" are gradually eliminated, it should be the future aim of every one of us to see that we (as members) get *good* representation on the Board of Directors, and that the Society as a whole benefits from the experience and judgment of the *best men obtainable as* DIRECTORS.

—RRP

Editor's Notes

1. Secretaries, Directors, Correspondents Listed in This Issue

As promised in the October issue of the JOURNAL, we are publishing elsewhere in this issue an up-to-date list of all Section Secretaries, Directors and JOURNAL Correspondents. As a result of questionnaires sent to all Sections, this list is as correct as it is possible to make it as of November 10, 1947. Only four Sections were not heard from in answer to our requests for this information, and in such cases the latest information available was used.

There may be changes by the time this is published, and there will be changes within a month or so as some Sections elect new officers. We will try to keep up with these changes in these columns from month to month, and intend to publish another complete list sometime this coming spring or early summer.

We would like to suggest at this time that if there are any errors in this table, any changes which may have occurred since this material was completed, or any blanks which can now be filled, your Editor be notified at once so that the information can be published.

2. Lost and Found

Your attention is called to an article under this heading elsewhere in this issue. We have not heretofore been called upon to run such a department, and probably will not again until next year's Conference. Under the circumstances, however, we feel that we are justified in performing this service this time, and will gladly do so again under similar circumstances.

3. Merry Christmas

Before the next issue of the JOURNAL reaches you, Christmas and New Year will have come and gone. We take this opportunity, therefore, to wish every reader, on behalf of the JOURNAL staff, the officers and the Executive Committee of the Society, a very Merry Christmas and a Happy and Prosperous New Yar.

Also, on January 10, 1948, we should all remember to wish ourselves a Happy Birthday. The Instrument Society of America will officially be 2 years old on that date.

4. The Needle Points to—

Chicago, Cleveland and Cumberland, for generally good reports. South Texas, for a novel idea—second paragraph.

General News

Report of Exhibitors' Advisory Committee

(By W. F. Haring, Chairman)

As a concluding activity of the 1947 Exhibitor's Advisory Committee, a dinner meeting was held Sunday evening, September 7, 1947, at the Stevens Hotel, at which some 71 exhibitors' representatives were present. The dinner came as a welcome respite from the day's heat and labor in setting up exhibits. The brief meeting which followed the dinner served to clear up all pending matters from the exhibitors' standpoint with regard to the following week's exhibit.

On Thursday afternoon, September 11, 1947, a meeting was held at which one representative from each 1947 exhibitor was invited to attend for the purpose of forming the 1948 Committee. Approximately 50 representatives were present, and the following committee was organized and is to be known as the 1948 Exhibitors' Advisory Committee:

W. F. Haring, Chairman (re-elected)—Wallace & Tiernan Products, Inc.
E. R. Fiske, Jr., Secretary—Leeds & Northrup Co.
R. C. Ayers—R-S Products.
W. C. Bennett—Penn Industrial Instrument Corp.
L. E. Elge—Fisher Governor Co.
W. J. Halpern—Gotham Instrument Co.
J. C. Koch—Conoflow Corp.
H. F. Lorence—Fischer & Porter Co.
A. O. Pearson—Brown Instrument Co.
C. D. Scott—General Electric Co.
D. H. Shallcross—Shallcross Mfg. Co.

Several problems and questions were presented to the Committee for consideration with particular regard to the 1948 show to be held in Philadelphia. Included are (1) agreement as to hours during which the exhibit will be open, (2) adequate allowance for time in setting up and tearing down exhibits, (3) provision for utilities, including gas, water and air, in-so-far as possible, (4) variety of depth of booths to satisfy the needs of all exhibitors, (5) limitations on height of exhibits with considerable latitude to be allowed in wall areas, (6) invitations to carry dates and hours when the 1948 show will be open (to be printed on next year's invitations), and (7), most important of all, consideration as to whether the exhibit should be held on annual or biennial basis.

An executive session of the Committee was held that same evening during which preliminary consideration was given to these various questions and partial agreement arrived at. A detailed review was made of the terms and conditions of the formal contract agreement between the exhibit management of the I.S.A. and the individual exhibitors who may contract for space at the 1948 exhibit. This consideration was based upon the drafting of a contract which would truly reflect the actual conditions of cooperation and coordination of interest between the Instrument Society of America, the show management, and the exhibitors.

As the name of this Committee implies, we shall endeavor to serve in the best interest of all exhibitors and, at the same time, promote the growth and expansion of the Instrument Society of America primarily by enhancing the quality of each succeeding year's exhibit. —W. F. Haring, *Chairman*.

National Electronics Conference

A good many I.S.A. members (both from Chicago and elsewhere) attended or participated in the National Electronics Conference held at the Edgewater Beach Hotel in Chicago, November 3, 4 and 5, 1947.

Several sessions of interest to I.S.A. members were presented, including two on Electronic Instrumentation, one on Computers, one on Industrial Applications and one on Nucleonics. The first session on Electronic Instrumentation was presided over by Major Behar, Editor of *Instruments*, and several of the papers presented were by I.S.A. members.

The National Electronics Conference, an annual affair, is a national forum on electronic research, development and application, and is sponsored by the Illinois Institute of Technology, Northwestern University, University of Illinois, American Institute of Electrical Engineers, and the Institute of Radio Engineers, with the cooperation of the Chicago Technical Societies Council, of which the Chicago Section of the I.S.A. is affiliated.

1948 Conference Committee Reports Progress

Tentative plans for the Third National Instrument Conference and Exhibit to be held in Philadelphia September 13 through 17, 1948, have been almost completed, according to a recent letter from Secretary Rimbach to the Board of Directors. At a recent meeting of the 1948 Conference Committee, the following program was discussed and approved. While unofficial at this time, it may be said that several of the phases outlined below are already arranged for, while the others are just getting under way.

Technical Sessions: The I.S.A. will arrange for eight technical sessions. These sessions are to run simultaneously with sessions of the co-sponsoring societies. Morning sessions will be held Monday through Friday from 10 a.m. to 12:30 p.m. Evening sessions will be held Monday, Tuesday and Thursday from 8 p.m. to 10:30 p.m.

Educational Sessions: The educational sessions of previous years will be continued.

Motion Pictures: It is planned to arrange a program of motion pictures on measurement and control subjects.

Historical Exhibit: An historical exhibit of instruments is scheduled to be set up on the Arena Stage.

Analog Program: A committee is to be appointed to investigate a program on analogs.

Banquet: The annual banquet has been scheduled for the Wednesday evening of the Conference week.

Exhibit Hours: Tentatively set for 10 a.m. to 6 p.m. on Monday, Wednesday and Friday, and 2 p.m. to 10 p.m. on Tuesday and Thursday.

Cooperating Societies: The following societies have been extended invitations, and all but one had accepted at this writing—American Institute of Physics; IIRD of ASME; Instruments and Measurements Committee of AIEE; and Joint Subcommittee on Electronic Instruments of AIEE. Tentative arrangements have been made as follows: (1) Each Cooperating Society will be offered a booth in the Exhibit; (2) Each Society will receive invitations for its members imprinted with the name of that Society (3) Each Society expressed interest in attending the I.S.A. banquet, but may have special luncheons; (4) Each Society will arrange two sessions to be held in a single day; (5) A general committee made up of a member from each sponsoring group will govern scheduling of meetings to avoid overlapping of interests.

(*Continued on Page 1154*)

Application Of Conventional Industrial Instruments To Power Plant Control*

By W. H. FORTNEY (General Foreman, Instrument Department, Humble Oil & Refinery Co., Baytown, Texas)

THE field of power plant control has been covered largely by engineers and suppliers who have produced specialized devices which have been limited in application. Most of these instruments and regulators are of extremely rugged design and are seldom used in general process work. But at present we find very few power plant engineers familiar with or interested in conventional industrial instruments, such as are now used in the chemical and process industries.

It is not my purpose to recommend any changes in the thinking or customs of any power plant operators, nor do I propose to establish myself as an expert in power plant operation.

It is my hope (as a member of the I.S.A. Recommended Practices Committee) to promote more thinking along the lines of standardization of instruments for measurement and control, for a greater variety of applications than we have at present. Every process plant has at least a few special instruments designed for particular jobs which would be practically worthless if the process were revised or discontinued. The ideal situation would be one where every instrument is 100 per cent reclaimable for use elsewhere when necessary to return to the company storehouse. This hardly applies to measuring instruments and controllers generally used for steam and power plant operations.

However, my organization has been able to successfully use conventional industrial instruments on most of the usual power plant applications, and this paper will describe some of these installations.

This discussion will be limited to the high pressure boiler installations at our Baytown Refinery. We have two of these plants, approximately one-half mile apart. There are a total of seven boilers operating at a nominal pressure of 600 psi. The first installation known as Steam Generating Plant No. 5, originally consisted of two boilers, each with a capacity of 350,000 pounds per hour, producing steam at 600 psi with 100° superheat. These were built in 1931. Two more boilers of equal capacity were added in 1937 and 1938. These boilers power three 7500-kw turbines.

The second plant known as Steam Generating Plant No. 6, has three boilers delivering 275,000 pounds of steam per hour each and supplies two 7500-kw turbines. The turbines at both plants are identical, and all discharge into the 150-pound yard steam distribution system.

Our discussion will cover these plants as separate units, describing first the controls on the water treating equipment, and then on steam generating equipment, of each.

No. 1 Water Treating Plant (Fig. 1)

This plant was originally designed to supply the first two boilers. Make-up water came from deep wells and there were few variations in total solids or hardness; condensate recovery averaged about 50% of the total feed water.

The well water used for make-up contains 600 ppm total solids, of which 360 ppm are bicarbonates. This water has a hardness of 28 ppm and a pH of 8.3; other impurities include 21 ppm of silica and 10 ppm of calcium.

Thus it is necessary to treat about 50% of the total feed. Condensate accumulates in two 10,000-barrel steel storage tanks and, of course, by-passes the water treating plant and is introduced into the suction side of the feed water pumps.

The well water is introduced into the clear well make-up section on liquid level control. The original control valve was operated directly from a float. This has been replaced by a shop-made pneumatic pilot-operated level controller and conventional control valve.

The first step in the treatment of raw water is to introduce acid in the clear well. Acid feed equipment on the original installation consisted of a measuring tank for "strong" acid, a lead-lined dilution or mixing tank, and a "Rube Goldberg" arrangement to feed the dilute acid into the clear well, as shown in Fig. 2. This feeding setup consisted of a lead-lined measuring box with the dilute acid level controlled by a direct-connected float valve. Acid was drawn from this box through a rubber "measuring" tube, the open end of which was positioned — through a float and a chain-and-pulley arrangement — by the dam height behind a weir.

With this system it was necessary to mix the dilute acid in batches, and the inaccuracy of control over the quantity injected is quite evident.

All of this equipment was replaced by a ratio-flow-controller. An orifice meter transmitter in the discharge of the clear well pump sets the control point on a rate-of-flow controller on the acid line. The measuring tank, mixing tank and constant level box have been dismantled. Since the concentrated acid storage tank has sufficient elevation above the clear well, the acid is introduced by gravity flow.

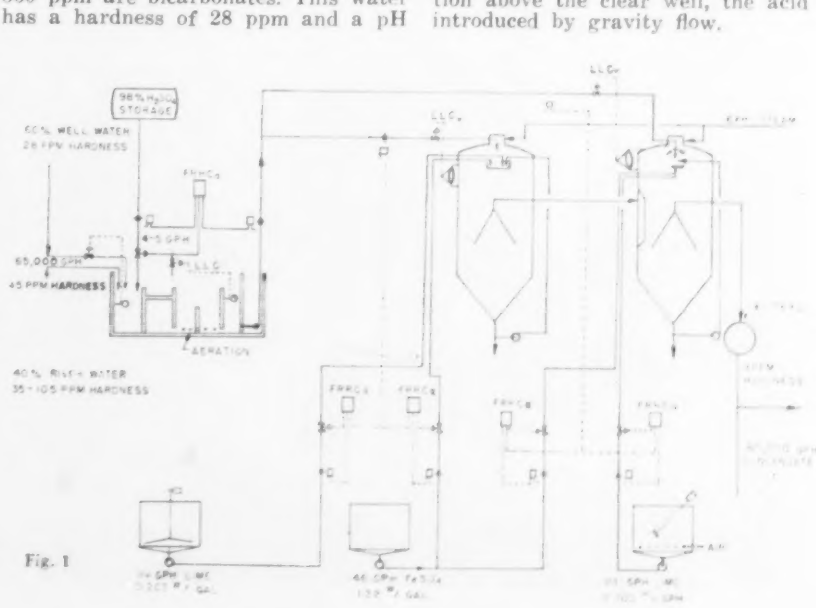

Fig. 1

The Author

Mr. Fortney has been actively engaged in instrument work for nearly 24 years, starting with the Texas Company in 1923. He has served as Electrical and Instrument Foreman in two small plants, becoming Foreman of the Baytown Refinery Instrument Department in March of 1937. This department has grown to meet the demands of a rapidly expanding plant (including a butadiene and butyl rubber plant, and the Baytown Ordnance Works, during the war) from 35 to 170 men.

In 1946 Mr. Fortney served as President of the Houston Instrument Society during its first year of organization. He was also a member of the Steering Committee during organization of the short course in "Instrumentation for the Process Industries" at Texas A & M College, and is serving his second year on that committee.

*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

The acid, which is 98% sulfuric, is metered in a 0.546" I.D. stainless steel tube with a 0.101" I.D. orifice. A 50-inch manometer is used with no seals; acid is in direct contact with the mercury end and parts. The control valve was made from a ½" angle valve body with conventional pneumatic superstructure. A 100-mesh stainless steel screen is installed ahead of the orifice.

The meter factor is 1 gph on a 0 to 10 square root scale. No difficulty has been experienced with this installation, although flows as low as 1.0 gph of acid have been controlled.

The middle section of the clear well is used for aeration to dispose of the carbonates which have been produced by the acid reaction. This is done with air from a blower, reducing the carbonate content to 2 ppm and the pH to 8.2.

The final section of the clear well forms a suction pit for the clear well pump. As an afterthought we installed a float in this section which operates a small valve to close the control valve on the acid in case the level drops.

The first settling tank, being of an early design, permitted treatment only with lime and a coagulant. Water to the settling tank was, and is now, on liquid level control; the only change was replacement of the lever valve with a pneumatic valve. Exhaust steam pressure of about 15 psi is held above the water level in the tank.

On the original installation we had an impeller type meter with gear train which operated intermittent electrical contacts as predetermined quantities of water were metered. These contacts started and stopped small motor drives to proportion the lime and coagulant feeds. The motors thus controlled were equipped with cable drums to lower swing lines into the solution tanks. The solutions were drained into small suction boxes ahead of centrifugal pumps which transferred the material into the settling tank. Pump suction was maintained by introducing condensate into the suction boxes through small float valves.

The contacts on the totalizing meter, the relays and the ratchet mechanisms

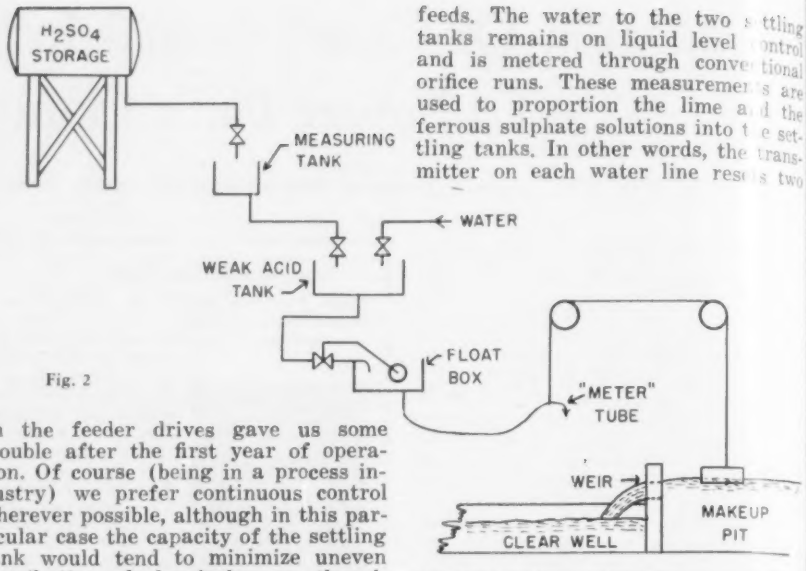

Fig. 2

on the feeder drives gave us some trouble after the first year of operation. Of course (being in a process industry) we prefer continuous control wherever possible, although in this particular case the capacity of the settling tank would tend to minimize uneven distribution of chemicals even though injection were intermittent.

Another settling tank and additional filters were added when the two newer boilers were installed. This second tank is of equal capacity but is equipped with a phosphate section.

During the war our industrial water supply was augmented by surface water from the San Jacinto River. This water has 225 ppm total solids, of which 75 ppm are bicarbonates and 21 ppm are calcium, and a hardness of from 50 to 55. The pH value is 8.3, which is the same as that of the well water.

Raw water is now proportioned 50-60% from wells and 40-50% surface water.

Original instrumentation on the second settling tank was identical with that on the first tank except that total water was metered through an orifice and integrating meter. This integrator operated contacts which drove the proportioning mechanism in the same manner as did the impeller type totalizer.

We have now replaced all the control equipment on the lime and coagulant feeds. The water to the two settling tanks remains on liquid level control and is metered through conventional orifice runs. These measurements are used to proportion the lime and the ferrous sulphate solutions into the settling tanks. In other words, the transmitter on each water line resets two chemical ratio controllers.

Thus, with conventional industrial instruments costing about 25% of that of the original installation, we get continuous proportioning with instantaneous response to changes in water flow. The ratio of chemical to water may be varied by the operator by merely adjusting a small lever in the control instrument.

The lime feed is measured in a standard one-inch pipe meter run with an orifice 0.446" in diameter and a meter factor of 4 gph on a 0 to 10 square root chart. Meter leads are purged with steam condensate. On our first installation we designed a flow nozzle because we were afraid of build-up of lime behind an orifice plate. However, we found that the lime was deposited in the bore of the nozzle, so an orifice plate was substituted and has been found to be perfectly satisfactory. Flow in the meter run is downward in a vertical line to prevent build-up behind the plate.

The ferrous sulphate solution is measured in a stainless steel tube 0.742" I.D. with an orifice of 0.225" diameter and a meter factor of 7 gph.

All of the water from the first settling tank flows into a partitioned section of the second tank, which is of later design. The total stream is then passed through anthracite filter and is combined with the returned condensate as boiler feed.

As stated before, the No. 1 tank did not have a phosphate section. After installation of the second tank, connections were made so that the water would flow in series from No. 1 to No. 2, combining in the phosphate section of No. 2. Up until this time, phosphate had been injected by hand control into the boiler drums. Measurement was by means of high pressure displacement meters, which gave considerable trouble and allowed no convenient means of setting the injection rate. The phosphate section of the No. 2 tank is not used as such, however, and it is still necessary to control the injection of phosphate into the individual boilers. This, however, is now done by ratio flow controllers. The rate is determined by the orifice meter on the feed water line to each boiler.

The phosphate solution meter runs are stainless steel tubes, 0.957" I.D.,

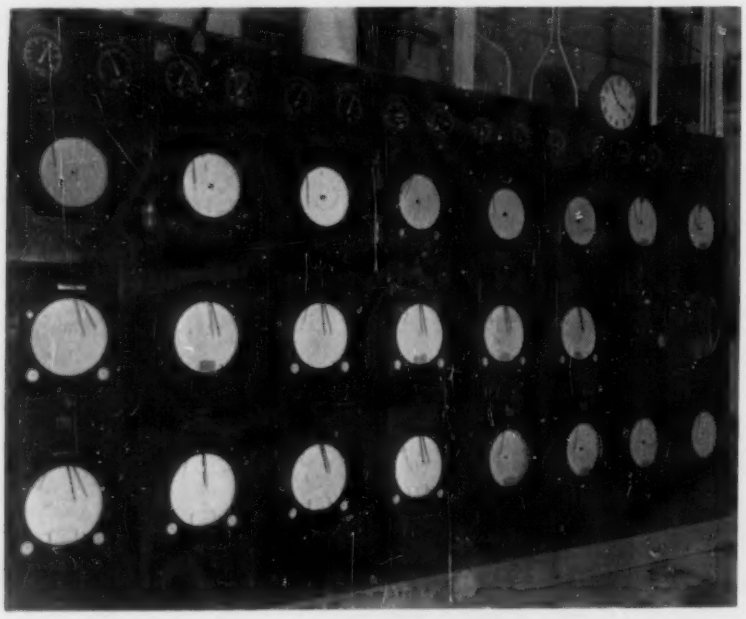

Fig. 3

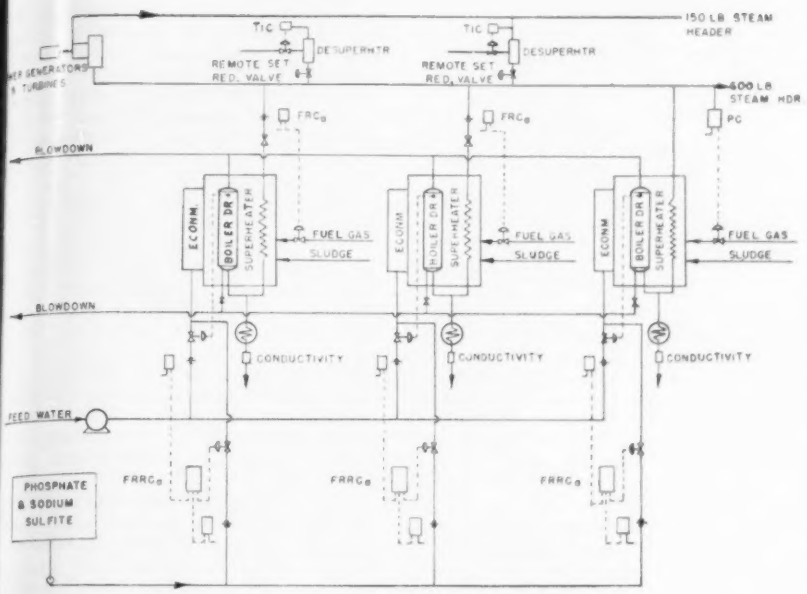

Fig. 4

ith an orifice of 0.225" diameter and meter factor of 7 gph. Sulphite is ixed with the phosphate and put di-ectly into the boiler.

In the treating plants we use dif-erential level recorders and control-ers (some of which are shown in Fig.) with shop-made range tubes. The evels in the chemical tanks and the inal section of the clear well are in-icated by bubblers and manometers. A conductivity recorder is installed on he panel and is so connected that it an be switched to any part of the four oiler leads.

Steam Generating Plant No. 5 (Fig. 4)

As stated before, we have four high pressure boilers at this plant which are controlled by conventional instruments —except that the original feed water regulators are still in use and are giving satisfactory service.

Fire control on these boilers is more of a problem than at the second high pressure boiler house we built. This complication is due to the fact that acid sludge from refinery process operations must be consumed by these boilers. This sludge contains coke and asphaltic materials which are difficult to measure on flow or pressure and are therefore fed by hand control at the burners. The additional heat comes from the yard fuel gas system and is on automatic control.

These boilers were originally operated on remote manual fire control. Three of them are now on fixed output control, fired on rate-of-flow control from the boiler leads. The rate-of-flow controllers operate conventional pressure balanced diaphragm valves on the fuel gas. This is, to our knowledge, the first application of rate-of-flow control to steam production. The fourth boiler is fired by pressure control on the high pressure steam header through a balanced valve identical with the others.

The three 7500-kw turbines are supplied from the 600-pound header and discharge into the 150-pound yard system. Three de-superheaters are used to deliver the excess 600-pound steam into the 150-pound system. These de-superheaters were originally installed to hold reduced pressure in the 150-pound system through hydraulic valves on two boilers and a pneumatic valve on the header. Temperature was controlled by bi-metallic thermostats.

Present instrumentation has been revised such that all three valves may be positioned pneumatically from the panel. This was accomplished by mounting a shop-made positioner on the two hydraulic valves and a 4 to 1 booster valve on the pneumatic valve, which operates at 0-60#. See Fig. 5.

The bi-metallic thermostats have been replaced by conventional mercury filled bulb-type temperature controllers, which in turn control the water injection to the de-superheaters.

These three valves are arranged for selective control: (1) remote manual

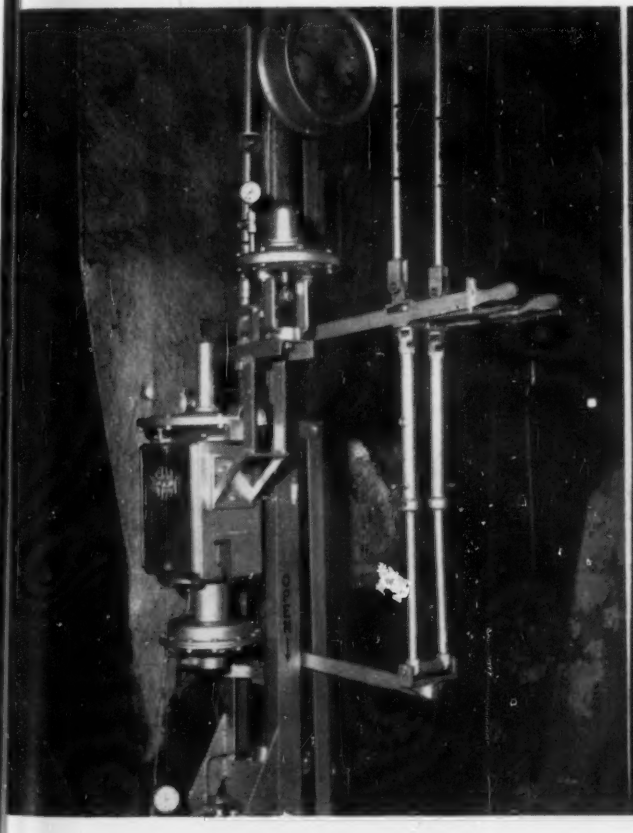

Fig. 5

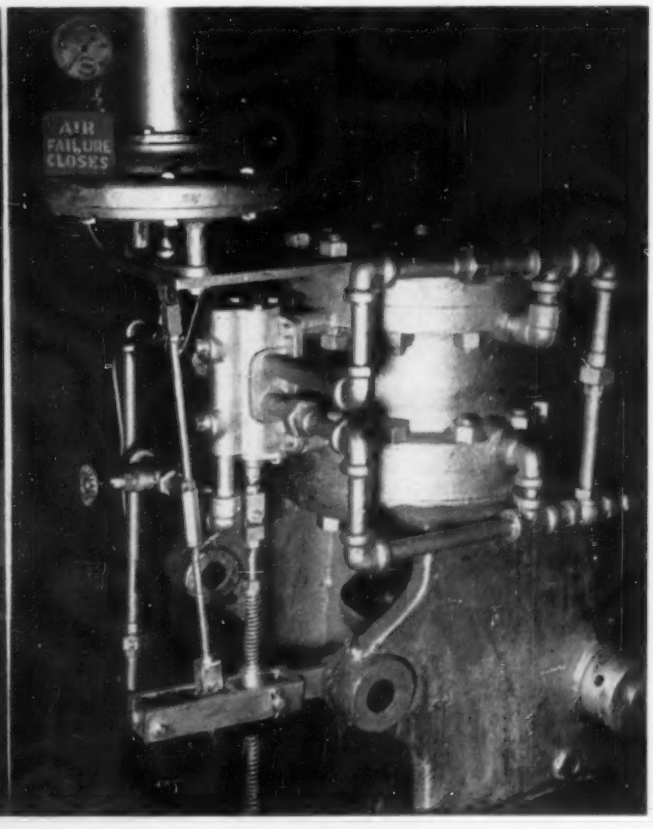

Fig. 6

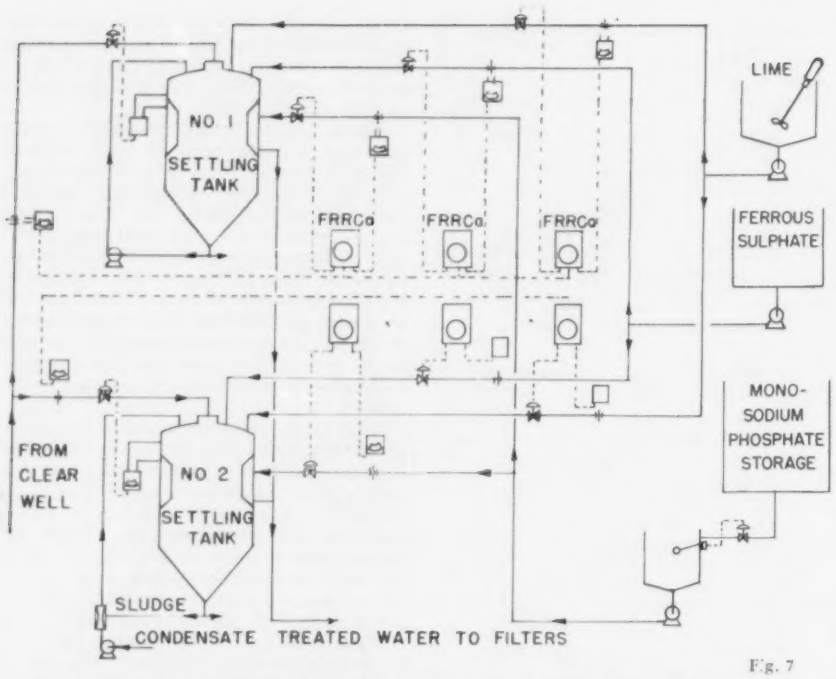

Fig. 7

rate-of-flow to the 150-pound system, (2) rate-of-flow from either boiler, (3) 600-pound header pressure, or (4) pressure on the 150-pound header. The method of control is varied to meet the demand of 600- or 150-pound steam, whichever is more desirable.

Induced and forced draft on the first and second boilers was originally controlled by push-button operation of motor drives on valves throttling the turbines. Pneumatic valves replaced the motor driven valves on these boilers. These valves are on remote hand control at present, but any conventional draft controller with a 0-15# air output may be adapted.

The two new boilers at this plant were originally equipped with hand control on the damper setting for induced draft, and locally mounted speed controls on blower turbine governors for the forced draft. The present installation uses automatic control on induced draft, with a shop-made remote positioner for setting the control point. See Fig. 6. The forced draft turbines are now controlled through remote positioning of the control point on the blower turbine governors. Complete automatic control is possible on this, but has not been accepted.

A complete new air-conditioned control room is being installed for this plant. All measurements, except steam and water pressure, will be pneumatically transmitted to the panel. Miscellaneous instruments now in use are to be relocated, including differential type level recorders, potentiometers (for recording miscellaneous temperatures), draft gauges, and a four-point strip chart CO_2 recorder.

The power house operates as a separate unit and only steam flow to the turbines is recorded at the boiler house panel.

No. 2 Water Treating Plant (Fig. 7)

The No. 2 water treating plant is supplied with well water, surface water and condensate. The normal make-up to the clear well is recovered cooling water from the turbines, from the jackets of some air compressors, and from the after-coolers of No. 2 Air Compressor Station.

The level in the clear well is controlled by a shop-made float actuating a pneumatic-hydraulic three-way valve (Fig 8) which diverts the excess water to a nearby cooling tower. A second pilot actuated from the same float provides emergency make-up water from the industrial system.

Chemicals used at this plant are acid to convert bicarbonates, lime, ferrous sulphate as a coagulant, and sodium phosphate mixed with sulphite to complete the precipitation.

In this plant the acid is introduced into a small mixing vat and is mixed in the main stream of water to the clear well through an orifice type incorporator. See Fig. 9. The CO_2 is removed in a deaerator instead of in a section of the clear well.

The original acid proportioning equipment consisted of an integrating flow meter which intermittently operated a series of helicoid gear pumps to inject acid into the small mixing vat. This system required considerable maintenance, both in electrical and mechanical respects. It has now been replaced by ratio rate-of-flow control on the acid line, using the same type of equipment as in the No. 1 plant. (Fig. 10.)

Rate-of-flow of the water to the first settling tank was originally used to position swing lines in the feed tanks of the other chemicals. The primary metering device was identical with the meter on the acid control. Justification of ratio flow equipment (Fig. 11) was easily developed when the second settling tank was proposed for this plant. Since duplicate instrumentation would be required on all chemical streams except acid, we dismantled the helicoid gear pumps and their supply tanks and eliminated the necessity of installing separate feed tanks for the other chemicals, which saving more than paid for the instrumentation for the complete unit.

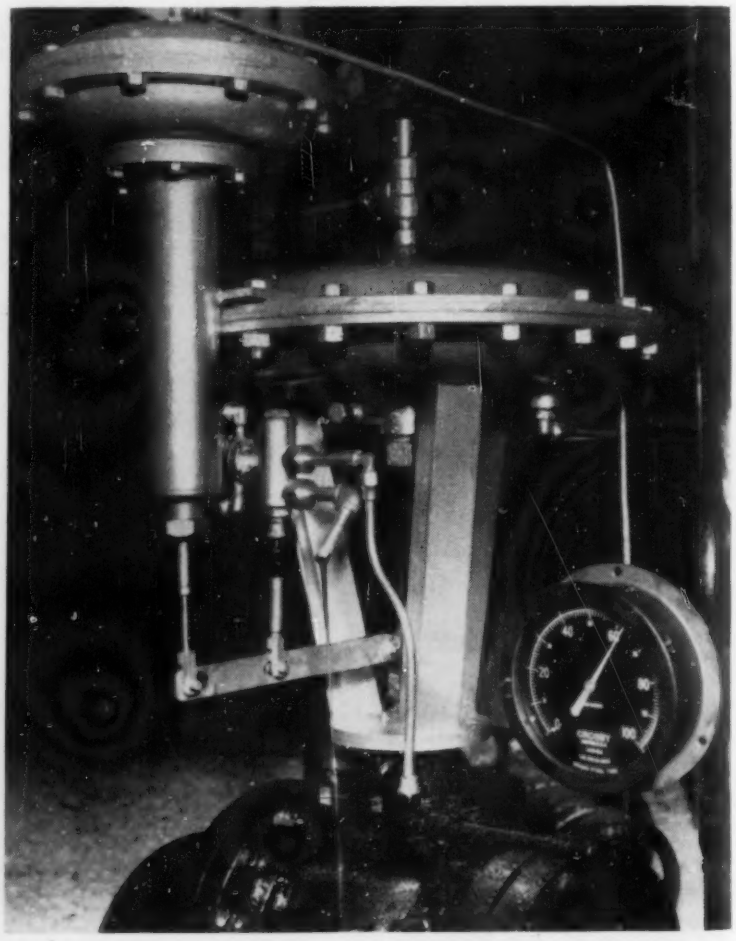

Fig. 8

Here again, all streams are now on ratio flow control, proportioned by the water flowing to the settling tanks. The settling tanks are of later design and have phosphate sections which are used as such. Thus all chemicals are retained in the water treating plant.

Steam Generating Plant No. 6

Our second high pressure boiler unit consists of three 600-pound boilers with a capacity of 275,000 pounds of steam per hour each. These boilers are supplied our No. 2 Water Treating Plant, and furnish steam to two 7500-kw turbines, identical with those at the older plant.

Instrumentation on this plant did not involve as much replacement as at the older plant. All measurements, with the exception of the first two de-superheater temperatures (which are now taken with bulb-type instruments) were made with conventional industrial instruments. Thus we could get control by replacing recorders with controllers.

The three boilers have been instrumentized for maximum operating flexibility. Each boiler has a pressure controller and a rate-of-flow controller on the boiler output; either instrument may be selected to actuate the pressure balanced valve on the fuel gas line.

Feed water make-up is controlled by thermostatic type regulators with reset and with constant differential valves ahead of the regulating valves.

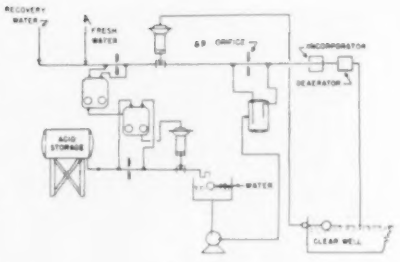

Fig. 9

This boiler house is operated on a constant load basis and is not used to maintain pressure in the 150-pound yard distribution system. A typical operation might be two boilers operating on pressure control and one on rate-of-flow control with all three of the de-superheater reducing valves on rate-of-flow control (or, probably, one on remote manual control.) The de-superheated steam temperature is controlled by condensate injection regulated by conventional bulb-type temperature controllers.

Two boilers have remote manual controllers governing the speed of fan turbines for draft control. The other boiler is equipped with a conventional instrument type draft controller operating the throttle to the induced draft fan turbine but this installation has never operated satisfactorily due to the fact that the fan has a very flat characteristic in the operating range, and wide variations in turbine speed are necessary to transverse the extremes of this flat portion of the curve.

On a constant load boiler, it seems that an optimum fan turbine speed could be used and more satisfactory control obtained with dampers.

There is some question as to the advisability of resetting the forced draft pressure from the feed water flow because of changes in the BTU content of the fuel gas. If a fuel of constant BTU were available, it seems that the forced draft could be controlled by either the steam production or the feed water flowmeters. If either of these systems should pressurize the wind box too far ahead of the change in firing rates, the control could be taken from the fuel gas flow.

It would be well to admit that considerable trouble has been experienced with all three of the reducing valves at this boiler house. Two of these valves operate in the range of 0-60 psi. Shop-made relay valves with output ratios of 4 to 1 make possible the use of conventional instruments to control them.

The third boiler is equipped with an angle or venturi type reducing valve. Unbalanced forces caused by the high rates of flow and high pressure drop were too much for the pneumatic actuator originally furnished. There was no relationship between control instrument output and valve stem travel. A hydraulic actuator was installed and we found that these upsetting forces were sufficient to break a $\frac{5}{8}'' \times 2''$ bar under edgewise strain! This arm or lever is approximately 20 inches long with a mechanical advantage of 4. We are now using a $\frac{3}{4}''$ bar 6 inches wide at the driving point. A solid roller bearing reduces the friction due to angular displacement.

Miscellaneous instruments are practically the same as those at the older plant, and include temperature, level, CO_2 and conductivity recorders. Pressure is maintained on a circulating fuel oil system for emergency use in case of fuel gas failure.

Further improvements are always possible. We have installed orifices in the blowdown lines and propose to control the blowdown by ratio to feed water. This is a very desirable improvement since it would effect economies in the heat balance, and a blowdown stream of consistent solid content would result. The blowdown lines are at present equipped with flow recorders.

Automatic cycle control of the filters is also possible. This could be accomplished by using pressure differential transmitters across the filters which would start cycle controllers to backwash the filter beds, purge them, and put them back on the line. Some real manpower savings are possible with a system of this kind, since the operators at present must manipulate a number of large gate valves with each filter change.

We would like to develop some means of measuring the consistency of the sludge from the bottom of the settling tanks, part of which is recirculated. This might be done with a sensitive density meter, which is doubtful; a turbidimeter might be used here—we have not investigated further. However, if it can be measured, we should be able to control it.

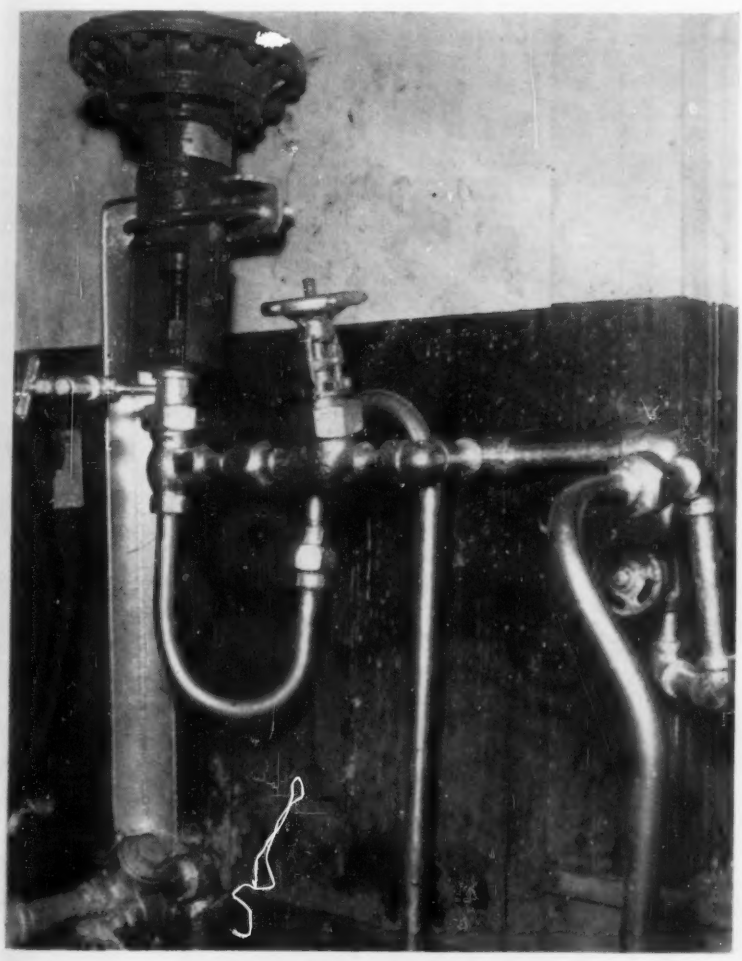

Fig. 10

Dry chemicals purchased in bulk could be injected by star feeders and some sort of continuous weighing device, which could be reset by a conventional instrument. Bulk chemicals are cheap provided material handling equipment is installed.

One of the greatest obstacles to the use of pneumatic control instruments has been the fear on the part of the operators that the air supply might fail. We have found that our air supply is far more dependable than electrical power, especially where steam driven compressors are used. No matter which type of power is supplied, a pump, a compressor or a generator is involved.

Conclusion

This information has been presented with the hope that it might contain something of interest to those engaged in the production of steam for either process or power supply. My organization is primarily and exclusively interested in the manufacture of petroleum products, and it is certainly not my intention to criticize or recommend changes in any practice in use today. This paper merely brings a story of what we have done, using equipment with which our maintenance organization is familiar and which we prefer to use wherever practical. At the same time, the results we have obtained have given us cleaner boilers, have reduced maintenance, and have saved in operating costs, including chemicals.

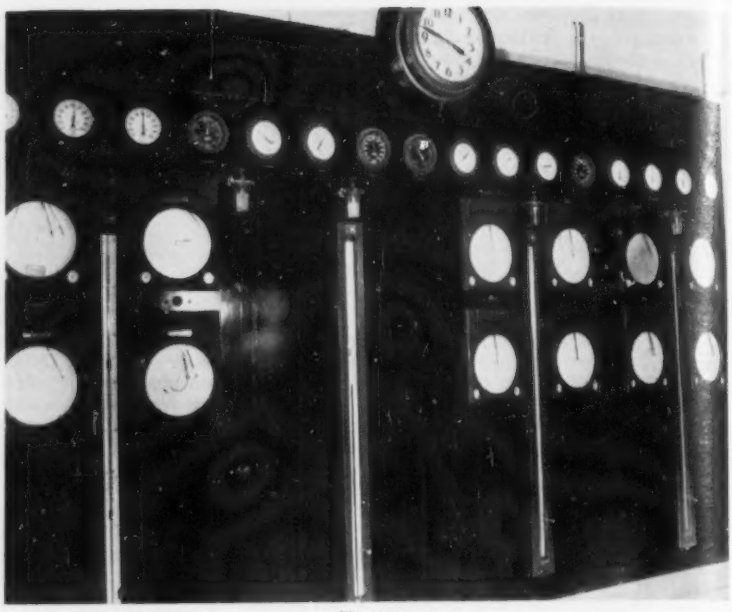

Fig. 10

General News *(Continued from page 1148)*

Further reports of the activities of the Philadelphia Convention Committees and Subcommittees will be published in the "Journal" from time to time as the tempo of their activities increases.

Official News

New York Regional Meeting

The New York Section has been making rapid progress on the program for the two-day regional conference on "Industrial Control by Electrical Methods" which is to be held in New York City on Friday and Saturday, January 30 and 31, according to latest reports from Ralph Batcher, Chairman of the Publicity Committee. All I.S.A. members and others interested in these fields are welcome. The program has been planned for complete coverage and continuity of material in each of the four technical sessions and one educational session.

With the primary objectives of the meetings in mind, speakers have been invited to contribute discussions and talks on their particular fields of activity. Most of the speakers have accepted these assignments, the program being arranged as follows:

Session No. 1—Friday, January 30, 9:30 a.m., Engineering Societies Building, 33 W. 39th St. Subject, "Application of Electrical Resistance Devices." This session will be devoted to a symposium on non-linear resistance devices—in general, those types which are of particular value as primary elements or as elements in electrical networks for changing a system's control characteristics. The subjects and speakers for this session are:

(1) "Temperature Sensitive Resistors in Industrial Measurement and Control Systems," a discussion of Thermistors and their uses, by J. E. Tweeddale, Application Engineer, Western Electric Co.

(2) "Characteristics and Applications of Thyrite Resistors," a discussion of resistance elements whose values are responsive to the applied voltage gradient, and their use as circuit elements, by E. J. Allen, General Electric Co. (Pittsfield).

(3) "Applications of Germanium (and Silicon) Rectifiers," a survey of the field of utility for simple rectifier units in industrial systems as rectifiers, oscillators and non-linear resistance elements, by Ernest H. Ulm, Sylvania Electric Co.

(4) "Humidity Sensitive Resistance Elements," a report on the application of resistor elements whose value depends upon the ambient humidity, by a Foxboro Company application engineer (name to be announced later).

Session No. 2—Friday, January 30, 2:00 p.m., Engineering Societies Building, 33 W. 39th St. The topics for discussion at this session are:

(1) "Strain Gage Applications in Commerce and Industry," a description of technics and recent fields of application of these units in the measurement of pressures and small displacements, by C. H. Gibbons, Baldwin-Southwark Division.

(2) "Light Sensitive Devices and Their Applications to Industry," a discussion of those characteristics of light sensitive cells which are of value in measurement and control applications, by A. T. Williams, Chief, Photometric Division, Weston Electrical Instrument Co.

(3) "Some Practical Aspects of Electrolytic Conductivity Measurements and Control," discussed as a factor in process control, together with descriptions of technics used, by Robert Rosenthal, Research Director, Industrial Instruments (Jersey City).

Dinner Meeting: Friday evening a sociable dinner meeting will be held at which a number of unusual electronic assemblies will be demonstrated, based on the subject "Electronic Fantasies." At this time important trivia will be set up and electronic solutions shown. This meeting will show that Electronics gives the answer, no matter what the cost!

Session No. 3—Saturday, January 31, 9:30 a.m., Columbia University, Broadway and 117th St. This session will be devoted to a discussion of commercial types of recorders and controllers, and will be directed by C. O. Fairchild. Representative models from several leading manufacturers will be demonstrated and/or displayed.

Session No. 4—Saturday, January 31, 3:00 p.m., Columbia University, Broadway and 117th St. This session will feature:

(1) A paper on "Electrical Analogs," plus

(2) A lecture-tour on "Computers" at the Watson Computing Laboratories.

Educational Session—A separate program for Saturday, January 31, is being arranged on the subject of electrical instrument repair and maintenance—this session being planned for the benefit of service and repair technicians. It will be divided into two sessions—one on "Principles of Operation" and the other on "Repair and Maintenance of Electrical Elements," both sessions to be conducted by operating repair-maintenance authorities and featuring practical demonstrations, including assembly and disassembly.

The final details of the Conference will be published in the January issue, and in addition, printed advance programs are to be sent to the Secretaries and Directors of all Sections. If anyone desiring to attend this Regional Meeting cannot secure a program from his local Section Secretary or Director (a complete listing of which will be found elsewhere in this issue—ED.), copies may be obtained by writing to Ralph R. Batcher, c/o Electronic Industries, 480 Lexington Ave., New York 17, N. Y., or to other members of Conference Committees listed below.

Committees

Program—Saul Young, Cambridge Instrument Co., Chairman; Prof. Carl F. Kayan, Dep't of Mech. Eng., Columbia University; R. R. Batcher, Caldwell-Clements, Inc.; H. L. Hildenbrand, President New York Section I.S.A.

Housing (Luncheon and Dinner)—Prof. Carl F. Kayan, Chairman; Herbert Proske, Wheelco Instruments Co.; H. H. St. Clair, Hart Moisture Gages Co.; Howard Kalbfleisch, Lummus Co.

Company Membership — E. E. Corbett, Rumsey, N. J., Chairman; L. V. Edwards, Instrument Associates, Inc.; R. E. Tarring, Instrument Associates, Inc.; George Kauer, Jr., Elmhurst, L. I.

Registration—Norman Cherry, 633 Willis Ave., Merrick, L. I., N. Y., Chairman.

Publicity—R. R. Batcher, Chairman; T. R. Olive and H. N. Blackmon, McGraw-Hill Publishing Co.; Stuart Rogers, Instruments Publishing Co.

Membership—Chas. E. Haggerty, Department of Public Works, Ward's Island, N. Y., Chairman.

Publication and Printing—Chas. D. Corey, Secretary, New York Section I.S.A., Chairman.

Facilities—E. B. Schofield, Sperry Gyroscope Co., Chairman; Walter F. Zenzer, Weksler Thermometer Co.; W. C. Bellis, Automatic Temperature Control Co.

Instrument Servicing Course—Henry O. Nilsson, Nilsson Electric Laboratories, Chairman; E. R. Manning, Weston Electrical Instrument Corp., Chairman.

According to Mr. Batcher, the hotel situation in New York may be rather critical; it is advisable to make reservations early.

105 Foreign Visitors at Conference

While the classification and analysis of the attendance at the Chicago Conference and Exhibit is not yet complete (at this writing), it has been carried far enough to know that there were 105 foreign visitors registered, according to Dick Rimbach, Executive Secretary. These were distributed as follows:

Australia	1	Russia	
Belgium	1	Canada	
Chile	1	England	
China	1	Czechoslovakia	
Cuba	1	Holland	
Greece	1	Sweden	
Iran	1	France	
Norway	1	Switzerland	
Spain	1	Aruba, N.W.I.	
Venezuela	1	Brazil	

I.S.A. SECTION SECRETARIES, DIRECTORS AND JOURNAL CORRESPONDENTS

(As of November 10, 1947)

Section	Secretary	Director	Journal Correspondent
ARUBA	M. R. Holly, P. O. Box 389, Lago Oil & Transport Co., Ltd., Aruba, Netherlands West Indies.	Wm. F. Hughes, Lago Oil & Transport Co., Ltd., Aruba, Netherlands West Indies.	Leroy L. McGrew, Lago Oil & Transport Co., Ltd., Aruba, Netherlands West Indies.
BALTIMORE	Felix Cox, Bethlehem Steel Co., Sparrows Point, Md.		
CALIFORNIA	Chris Wagner, 1105 West Fern St., El Monte, Calif.		
CENTRAL INDIANA	M. R. Underwood, 1235 West 33rd St., Indianapolis, Ind.		M. W. Hanson, P. R. Mallory Co., 3054 E. Washington St., Indianapolis, Ind.
CHARLESTON	Carl Cavander, 414 23rd St., Dunbar, W. Va.	Ralph D. Webb, Carbide & Carbon Corp., South Charleston 3, W. Va.	Allyn R. Phillips, Carbide & Carbon Corp., South Charleston 3, W. Va.
CHICAGO	Floyd E. Ertsman, 3538 So. Wabash Ave., Chicago 15, Ill.	Earl C. Rieger, 1427 Walnut Ave., Western Springs, Ill.	Sylva Mae Dushkes, 8024 So. Honore St., Chicago 20, Ill.
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CLEVELAND	Clark H. Joy, 6523 Euclid Ave., Cleveland 3, Ohio.	Harvey L. Lee, 20599 Morewood Parkway, Cleveland, Ohio.	L. H. Waldrip, 3929 Strandhill Rd., Cleveland 20, Ohio.
CUMBERLAND	Clyde Babst, 225 Cecelia St., Cumberland, Md.	Harry Stern, Hercules Powder Co., Box 210, Cumberland, Md.	G. William Harrison, Hercules Powder Co., Box 210, Cumberland, Md.
DETROIT	J. W. Head, Industrial Electronics, Inc., 21 Henry St., Detroit 1, Mich.	Jack Richardson, Brown Instrument Co., 415 Brainard St., Detroit, Mich.	Wm. E. Wilson, 21615 Middle Belt Rd., Farmington, Mich.
EASTERN NEW YORK	W. J. Claffie, 407 State St., Albany, N. Y.	George F. Gardner, 408 Charles St., Scotia 2, N. Y.	Secretary
GULF COAST	A. E. Bunn, 2237 North St., Beaumont, Tex.	R. L. Nichols, 715 Madison St., Beaumont, Tex.	R. M. Howe, 2643 Harrison St., Beaumont, Tex.
KANSAS CITY	R. L. Lewis, 2236 East 67th Terrace, Kansas City, Mo.	Oliver L. Boutros, Boutros Instrument Lab., 1627-29 E. 31st St., Kansas City, Mo.	Wm. A. Reichow, Minneapolis-Honeywell Reg. Co., 1625 E. 31st St., Kansas City, Mo.
LOUISVILLE	Sid Hawkinson, Brown Instrument Co., 633 So. 5th St., Louisville 2, Ky.	E. H. C. Brown, c/o Joseph E. Seagram's, 7th St. Rd., Louisville, Ky.	Secretary
NEW JERSEY	George R. Feeley, 22 Bailey Road, Maplewood, N. J.	Harry F. Moore, Birch Hill Rd., Mountainside, N. J.	H. M. McCarthy, Standard Oil Development Co., P. O. Box 37, Elizabeth, N. J.
NEW ORLEANS	W. H. Haney, 1016 Esplanade Ave., New Orleans 16, La.		
NEW YORK	Charles D. Corey, Route 2, Box 422, Huntington, Long Island, N. Y.	Ralph R. Batcher, Electronic Industries, 480 Lexington Ave., New York 17, N. Y.	Secretary
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NORTHERN INDIANA	C. P. Haynes, Red River Oil Refinery, 935 177th Pl., Hammond, Ind.	Secretary	J. Baum Beckman, 3210 Arthington, Chicago 24, Ill.
OAK RIDGE	J. O. Alexander, 101 Hoyt Lane, Oak Ridge, Tenn.	N. L. Isenhour, 100 Everest Circle, Oak Ridge, Tenn.	Secretary
ONTARIO	A. J. Legault, The Bristol Co. of Canada, Ltd., 71 Duchess St., Toronto, Ontario, Canada.	R. B. Jackson, Roydes & Edwards, Ltd., 104 Lombard St., Toronto, Ontario, Canada.	Secretary
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PITTSBURGH	L. M. Susany, Carnegie Institute, 4400 Forbes St., Pittsburgh, Pa.	Albert H. Shafer, The Foxboro Co., 5151 Baum Blvd., Pittsburgh, Pa.	Andrew G. Young, 206 Curtis St., Pittsburgh 21, Pa.
PRESQUE ISLE	Roger P. Marshall, 161 West Main St., North East, Pa.	E. X. Yarletts, 110 West Third St., Oil City, Pa.	Secretary
ST. LOUIS	William G. Lee, 4710 Delor, St. Louis 16, Mo.	Wm. E. Boyle, 821 Hale Ave., Edwardsville, Ill.	H. E. Zeffren, 5625 Enright Blvd., St. Louis 12, Mo.
SARNIA	R. K. Chamberlain, 314 Maria St., Sarnia, Ontario, Canada.		L. Gilbert, 364 Cobden St., Sarnia, Ontario, Canada.
SOUTH BEND	George E. Gilliam, Brown Instrument Co., 225 Christman Bldg., South Bend, Ind.	Prof. J. G. Buck, Dep't of Physics, Univ. of Notre Dame, Notre Dame, Ind.	Marius Wolf, 2012 Homewood, Mishawaka, Ind.
SOUTHERN MICHIGAN	R. J. Schofield, 203 E. Hammond, Otsega, Mich.	Ken Mead, 1919 Buena Vista, Kalamazoo, Mich.	Secretary
SOUTH TEXAS	Homer C. Givens, P. O. Box 125, Falfurrias, Tex.	Secretary	Mrs. Beulah M. Smith, 1448 Southgate Drive, Corpus Christi, Tex.
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TULSA	C. R. Horton, Macnick Division, 510 South Lansing, Tulsa, Okla.		
TWIN CITIES	Ray Hopper, Minneapolis-Honeywell Reg. Co., 2753 4th Ave. So., Minneapolis 8, Minn.	R. Marchant, Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul 6, Minn.	Secretary
WASHINGTON	G. M. Rolls, American Instrument Co., 8010-20 Georgia Ave., Silver Spring, Md.	Ralph L. Goetzenberger, Minneapolis-Honeywell Reg. Co., 1919 K St. N.W., Washington, D. C.	Secretary
WAYNE COUNTY	R. L. Swenson, 2141 Oak St., Wyandotte, Mich.	Wm. G. Baker, 2446 4th St., Trenton, Mich.	John MacPherson, R.F.D. No. 1, Wyandote, Mich.

Section News

Central Indiana

At the November meeting the members of the Central Indiana Section had the privilege and pleasure of hearing a talk on "Instrumenting a Continuous Chemical Process," by Mr. H. C. Frost, Assistant Director of Engineering, Corn Products Refining Company, Argo, Ill., and newly-elected Vice-President of the I.S.A.

In his talk, which was illustrated with slides, Mr. Frost set up a hypothetical chemical instrumentation problem, and then discussed the various phases of action required to arrive at a satisfactory solution. The interest with which the attending members pursued the discussion following Mr. Frost's talk indicated how well his excellently presented address was received.

At the conclusion of the talk, President Harvey Rockwell introduced those nominees present who are to be voted on at the December 2nd meeting to fill offices of the Section for 1948.

The program for the December 2nd meeting will be an illustrated talk on "The Development and Application of Concentric Scale Instruments" by Mr. A. J. Corson of the Instrument Development Section of General Electric Company.

—M. W. Hanson, *Corr.*

Chicago

Approximately 100 members and guests of the Chicago Section attended the November 3d meeting at the Piccadilly Tea Room in Chicago. The speaker of the evening was Mr. V. D. Hauck, Chief Engineer of the Friez Instrument Division of Bendix Aviation Corporation, and his subject was "Radiosondes." The function of Radiosonde equipment, Mr. Hauck explained, is to measure the upper air conditions affecting our weather, an ever timely subject.

Mr. Hauck gave a brief resume of the effect of upper air conditions on the weather at ground level, and went into considerable detail about the instruments used for measuring temperature, humidity and other conditions at high altitudes. Slides were used to show the equipment used by the Military forces and the Weather Bureau for the measurement of these conditions. An interesting question and answer period followed the talk.

Among out of town guests at the meeting were President E. H. C. Brown of the Louisville Section, Major M. F. Behar, Editor of INSTRUMENTS, who spoke briefly, and Ralph Batcher, Executive Editor of TELETECH and Director from the New York Section, who outlined briefly the plans for the New York Regional Meeting to be held on January 30 and 31.

"Servomechanisms" will be the subject at the January 5th meeting, to be presented by Albert F. Sperry, President of Panellit, Inc., and a Past-President of the I.S.A.

—Sylva Mae Dushkes, *Corr.*

Cleveland

The Cleveland Section's second regular meeting of 1947, held on October 22nd, brought out 75 members and guests to hear Dr. W. N. Greer of Leeds & Northrup Company discuss the subject of "pH Measurement and Control in Industry." Dr. Greer succeeded in telling the story of pH in such a way as to make it understandable and interesting, and added much to our knowledge of the subject. A lively discussion period brought out many of the points involved in successful application of this type of equipment to a variety of problems.

The November meeting is scheduled for November 18th, at the Cleveland Engineering Society, when we hear our own Section Vice-President, Arthur Hejduk, of the Meriam Instrument Company, discuss "Manometer Applications in Industry."

No meeting is scheduled for December because of the holiday season, our next meeting being scheduled for January 27, 1948. Our speaker will be Mr. R. A. Rockwell of Mason-Neilan Company, whose subject is to be "Liquid Level Measurement and Control."

—L. H. Waldrip, *Corr.*

Cumberland

The Cumberland Section held its regular monthly dinner-meeting Tuesday, October 28th, at Shaw's Cafe, R. W. Wilson acting as toastmaster in the absence of President Harry Stern.

The speakers of the evening were Miss L. M. Suckfield of Gulf Research & Development Company and Mr. M. F. Behar, Editor of INSTRUMENTS magazine.

Miss Suckfield's talk was entitled "Wet Test Meters, Their Operation and Calibration." She gave a very detailed discussion of the instruments and further illustrated her points with slides of actual percentage-error curves. Miss Suckfield and Mr. W. K. Bowman, also of Gulf Research, answered questions on the subject after the talk.

Major Behar spoke on "Thermometer and Pyrometer Calibration." His talk on the development and present day use of thermometry was extremely interesting and his unique demonstrations added to the interest of his talk.

The next meeting, to be held on November 25, will feature Mr. C. B. Moore, of Moore Products, who will speak on "The Solution of Instrumentation Problems by the Pneumatic Null Balance Method."

—G. William Harrison, *Corr.*

Detroit

The October meeting of the Detroit Section included:

1. A short business session concerned with phraseology in the by-laws and constitution of the Section.
2. A talk by Mr. Wesley Erwin of General Motors Research on "The Automatic Sonigage."
3. A talk by Mr. Edwin E. Puls of Cities Service Oil Company on "The Industrial Heat Prover."
4. A demonstration of the Aeroquip Hydrauliscope by the Aeroquip Corporation of Jackson, Mich.

The Automatic Sonigage was described by Mr. Erwin as an ultrasonic instrument for rapid fault-detection and thickness gaging. The device uses a spring-retained quartz crystal to set up half-wave vibrations in the materials under test, the crystal being driven by an oscillator and the intelligence being converted into visual patterns on the screen of a cathode-ray oscilloscope.

Mr. Puls discussed the uses of the Industrial Heat Prover. This convenient and portable device consists essentially of a pyrometer and a catalytic combustion gas analysis instrument for both oxygen and combustibles. Mr. Puls discussed many instances of fuel savings and reduction of scrap by means of the Heat Prover.

The working demonstration of the Aeroquip Hydrauliscope attracted much attention. Bargain-basement techniques were required to get a quick look at the equipment.

The November 18th meeting will feature Harry F. Moore, Standard Oil Development Company (and Director from the New Jersey Section), speaking on "Organization of the Instrument Department."

The December meeting, scheduled for the 16th, will bring us Mr. M. Good, of Diamond Power Specialties, speaking on "Practical Television in Industry."

—W. E. Wilson, *Corr.*

Dr. Dwight F. Windenburg

(*Washington Section*)

Dr. D. F. Windenburg, a past Vice-President of the Washington Section and well known throughout the I.S.A., died in Mount Alto Hospital in Washington on Friday, November 14th, following a heart attack in his home in Chevy Chase, Md., the previous evening.

Dr. Windenburg was born in Lamont, Iowa, in 1895, was a graduate of Cornell College, Mt. Vernon, Iowa in 1921, and received his master's degree in physics there in 1923. After teaching for several years, he went to Washington in 1929 as a physicist with the experimental model basin in the Navy Yard, now known as the Gun Factory. He received his Ph.D. degree in physics from Catholic University in 1939. He was a member of Phi Beta Kappa and Sigma Xi.

At the time of his death, Dr. Windenburg was Chief Physicist and civilian supervisor of the structural mechanics division of the David Taylor Model Basin, as well as advisor at the Gun Factory and a member of several other Army-Navy and Government committees and boards. He was a member of the American Society of Mechanical Engineers, the Society for Experimental Stress Analysis, the Philosophical Society of Washington, and the Instrument Society of America.

Dr. Windenburg was very active in the affairs of the I.S.A., having been one of the organizers of the Washington Section, and serving as Vice-President of that Section during 1946.

Eastern New York

The second fall meeting got well under way on Tuesday, November 4, at Siena College with a "Discussion of Selected Subjects" by Section members. After reports by the Program Committee on the Annual Dinner Meeting next month, the Employment Committee on the objectives and available services to members, and the Nominating Committee which presented the slate for election at the Annual Meeting next month, the meeting was turned over to Mr. J. Brandeau, Chairman of the Education Committee, who introduced the speakers of the evening.

The first was Mr. M. D. Smith, of the Davis Emergency Equipment Company, who explained the basic principles of Gas Analysis, and then introduced Mr. F. R. Davis, Jr., who explained and demonstrated the new Davis Micro-Gas Analyzer. Mr. Davis explained that the instrument analyzes any gas in the toxic range which will ionize in water or which, when decomposed by heat, will ionize in water. He was called upon to answer many questions, both during and after the meeting, on the operation, accuracy and scope of the analyzer.

When this phase of the meeting was concluded, the meeting was turned over to Mr. H. G. Murry, of the Skaneateles Manufacturing Company, who enlightened us on vacuum measurement by means of the "Skanascope." This instrument operates on the glow-discharge tube principle and will read in the region below that of a manometer. He explained that it could be incorporated to control as well as measure a vacuum process.

The next meeting is to be held December 2, at which time Mr. Richard Pond of the Taylor Instrument Companies, Rochester, N. Y., will talk on "The Basic Principles and Mechanisms of Air-Operated Controllers." This is also the annual meeting for the election of officers.

The January meeting will be held on the 6th at Siena College in Loudenville, preceded by dinner at the Circle Inn in Lathams Corners, and will feature Mr. P. A. Elfers of Fisher Governor Company, Marshalltown, Iowa. His subject is to be "Practical Application of Valves in Automatic Control."

—W. J. Claffie, *Corr.*

Kansas City

December 16, 1947—"Unusual Instruments in Exploration, Drilling and Production Operations in the Petroleum Industry," by L. W. Swift, Chief Engineer, Engineering Laboratories, Inc., Tulsa, Oklahoma. Place—The Crossroads; dinner at 6 p. m., meeting at 7:30. —William A. Reichow, *Corr.*

Oak Ridge

The November 5th meeting was called to order by President Charles Covey following the usual dinner at Grove Recreation Hall. After the business portion of the meeting "Tiny" Isenhour, our program chairman, introduced the speaker of the evening, Mr. T. B. Burris, Assistant Sales Manager for Chemical and Petroleum Industries Division of Fisher Governor Co. of Marshalltown, Iowa, who spoke on "Diaphragm Motor Valve Characteristics."

His talk dealt with all types of motor operated control valves, beginning with the old style V-port type on through the latest developments in the world of valves. A discussion was held on the various types of gland packing and lubrication, the relation between flow and diaphragm pressure and percentage type characteristics, as well as the superstructure itself. The usual question and answer session followed the talk.

—J. O. Alexander, *Sec'y.*

Philadelphia

The 50th meeting of the Philadelphia Section was held at the Penn-Sheraton Hotel Wednesday evening, October 15th. As each member entered the meeting room he had the opportunity to write a brief note to Ted Newcomb on a strip chart from a temperature recorder. (Ted was injured in an airplane accident last summer and all members were anxious to convey some kind of message from the Society.)

The meeting was a very eventful one. Dick Rimbach was a visitor and the first speaker. He had a pleasant surprise for the Philadelphia Section. In recognition of having had the most members in attendance at the Annual Banquet in Chicago in September, the Philadelphia Section was presented with a large banner bearing the official insignia of the I.S.A.

Mr. Rimbach's talk and presentation was followed by a report from Mr. R. B. Galley, Chairman of the Nominating Committee. Nominees were named and some nominations were made from the floor.

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA, 1117 Wolfendale St., Pittsburgh 12, Pa.

INSTRUMENT ENGINEER for maintenance and repair of all instruments in plant manufacturing rayon yarns. Should have development ability and experience for design and application of instruments to control new processes. Salary open to discussion. Location North Carolina. Box 83.

INSTRUMENT TECHNICIAN for complete servicing of indicating and recording instruments and multimeters and should be familiar with the use of power tools. Single. Give experience and education in first reply. Location New Mexico. Box 84.

INSTRUMENT ENGINEER OR TECHNICIAN with sales ability for junior Sales Representative to represent large and long established instrument manufacturer in Chicago area. Experience with temperature and pressure recorders required. Desirable to own car but not necessary. Salary open to discussion. Box 85.

INSTRUMENT TECHNICIAN to take complete charge of instrumentation in the three plants (located in one city) of a large brewing company. Applicant must have car. Instrumentation consists of temperature recorders and thermometers of the filled tube type, pressure recorders and pressure and vacuum gauges, and all boiler room instruments. Must be able to maintain and calibrate these instruments. Should have five years experience in instrumentation in food processing, refrigeration or chemical industry although this requirement is not obligatory. 40-hour week. Salary open to discussion. Location Illinois. Box 86.

ENGINEER—"AERONAUTICAL OR MECHANICAL OR ELECTRICAL (INSTRUMENTS)" for National Bureau of Standards, Washington, D. C. Applicants must have completed successfully a standard professional engineering curriculum leading to a bachelor's degree in a college or university of recognized standing. In addition to the above, applicants must show experience as follows: For P-2 grade of position (Entrance Salary $3397): One year of professional engineering experience in one of the branches of engineering. For P-3 grade of position (Entrance Salary $4149): Two years of progressive professional engineering experience, including at least 1 year of moderately difficult and important work in one of the branches of engineering. Credit will be given for all valuable experience of the type required, regardless of whether compensation was received or whether the experience was gained in a part-time or full-time occupation. Graduate study in engineering successfully completed may be substituted for experience. Qualified applicants write for application to Box 87.

MANUFACTURERS' REPRESENTATIVES for new portable precision instrument for non-destructive measuring of corrosion and wall thickness from one side of metallic surfaces. Important advance in the inspection of boiler drums, process vessels, pressure vessels, pipe lines, ship hulls, stills, etc. Protected territories open. Give qualifications and list of other companies represented in first letter. Box 88.

MANUFACTURERS' REPRESENTATIVES by large manufacturer of electronic instruments, oscillographs, recorders, d-c amplifiers, analyzer for non-destructive testing of metal plates, etc. Territories open: Chicago including Wisconsin and Eastern Iowa; St. Louis; State of Texas; South Eastern States. Give full particulars of present operations. Box 89.

MANUFACTURERS' AGENTS by long established manufacturer. Program controller for almost unlimited process sequences or coordination, time cycle controllers, pressure controllers, hydraulic operating valves. Boston, New York and Philadelphia territories. Should be well qualified and have wide acquaintance in process industry. Box 90.

SALES MANAGER for rapidly growing manufacturer of gages and dead weight testers. Requirements: Under 35, mechanical engineering graduate, experience not necessary but must have sales personality and be able to develop applications. Location. Cleveland, Ohio. Box 91.

SENIOR DRAFTSMAN with minimum of five years experience with an electrical instrument company or with a company manufacturing pyrometers and associated equipment. Will eventually lead to designer's position. Desirable that applicant have some background in shop practice, use of machine tools and be acquainted with various types of casting material. Salary open to discussion. Location New Jersey. Box 92.

SALES ENGINEER by Hammell-Dahl Co. Applicant should have full experience in automatic control problems, particularly along the lines of proper application of control valves. To be stationed Philadelphia area. Salary open to discussion. Successful applicant would come under company salary and bonus set up. Box 93.

INSTRUMENT TYPE DRAFTSMAN must be broad experienced for oil refinery and chemical plant designing. Permanent position with eastern engineering co. Salary commensurate with capacity and responsibility. State experience in detail. Box 94.

INSTRUMENT ENGINEER experienced in design and fabrication of process control systems. Salary open to discussion. Location Chicago, Ill. Box 95.

INSTRUMENT SUPERVISOR OR MECHANIC must be thoroughly familiar with and capable of maintaining and repairing instruments for process control systems. Location Chicago, Ill. Box 96.

PROJECT ENGINEER instrument experience desirable but must have at least five years experience in practical operation of processes in the chemical, rubber, plastics or oil refining industry. Qualification is needed for supervising as well as following in detail the overall process in synthetic rubber Pilot Plant work. Salary $4200 to $4800 per year. Location Akron. Box 97.

INSTRUMENT REPAIRMAN for vacancy in Instrument Repair Department of large steel company. Must be thoroughly familiar with power plant and temperature instruments. Location Buffalo, N. Y. Box 98.

The speaker of the evening, Mr. Gordon Volkenant, Assistant Director of Research for Minneapolis-Honeywell Regulator Company, was introduced by Bill Steincamp of the Brown Instrument Company. The talk and demonstration given by Mr. Volkenant on Electronics was excellent. Not only was it too good for an attempt to be made here to give a resumé, but, like a good book or play, it was also too good to be spoiled for others who may have an opportunity to hear the talk later. One of the main objectives of Mr. Volkenant's talk was to take the "bugaboo" and mystery out of Electronics. He certainly accomplished his objective.

There was a record attendance for the meeting, even though the weather was very warm and humid.

President George Ehly extended the thanks of the Section to Mr. Volkenant for his very fine talk, and after a short period of questions and discussion, the meeting was adjourned.

The December meeting, Wednesday the 15th, will feature Mr. Robert L. Hurley of duPonts Instrument Engineering Department, who will conduct a discussion on "Instrumentation in Chemical Plant Design."

—CLARENCE B. PETTY, *Corr.*

PITTSBURGH

The October meeting of the Pittsburgh Section was held at the lecture hall of Carnegie Institute on Monday, October 27. Prior to the regular meeting, dinner was served in the Institute cafeteria. At each plate was found a three-minute egg timer presented with the compliments of Mr. G. S. Frazee of the Automatic Temperature Control Company. Mr. Bremer had a supply of the new I.S.A. lapel pins which he sold to the members.

After dinner the members and guests adjourned to the lecture hall and the regular meeting was called to order. Minutes of the preceding meeting were read by Secretary Susany and the Treasurer's report was presented by Clark Fry. Mr. Bowman gave a report on the progress of the new instrument training course which was inaugurated in September at the Connelly Trade School. This training course elicited much interest. There were 100 applicants, but owing to school limitations only 40 could be admitted.

Mr. Knapper reported on plans for next year's convention which will be held in Philadelphia in September.

The technical portion of the meeting was divided between three speakers. Miss Louise Suckfield, of the Gulf Research and Development Company and one of the instructors in the aforementioned instrument training course, gave a paper on "The Operation and Calibration of Wet Test Meters." Major M. F. Behar, Editor of *Instruments* magazine, presented a paper on "Pyrometry." Mr. R. L. Cox, of the Hayden Chemical Company, Morgantown, W. Va., spoke on "Industrial Instrument Maintenance" in place of Mr. Roy Meyers of the same company who was originally scheduled to give this talk but who was unable to be present.

—A. G. YOUNG, *Corr.*

ST. LOUIS

The regular November meeting of the St. Louis Section was held at the Engineers' Club on Tuesday, November 4, 1947. The speaker was Mr. W. P. Myers, Jr., Application Engineer for Alco Valve Company of St. Louis, who spoke on "Automatic Controls for the Refrigeration System."

Mr. Myers described the temperature sensitive control system designed to maintain a constant superheat at the cooler outlet regardless of changes in suction side pressure, and explained the control valves and their power amplifying arrangements. He also described arrangements used with solenoid valves in larger sizes, pointing out what the user can do to aid in the successful operation of such valves.

The talk was presented with the aid of slides, and in Mr. Myers' usual clear and informative manner. This very interesting talk was enjoyed by approximately 65 members and guests.

—H. E. ZEFFREN, *Corr.*

SOUTHERN MICHIGAN

December 10, 1947, "Electrical Measuring Instruments—Their Construction, Operation and Selection," by Mr. Roy Teetsell, Westinghouse Electric & Mfg. Corp., Lima, Ohio.

January 14, 1948, "Permanent Magnets," by Mr. C. A. Maynard, Indiana Steel Products Co., Valparaiso, Ind.

—WADE ALLEN, *Prog. Chmn.*

SOUTH TEXAS

With President McCaleb on vacation, Vice-President C. M. Carson called the regular November meeting to order on Tuesday,

Laboratory Standards

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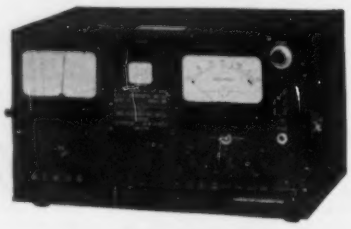

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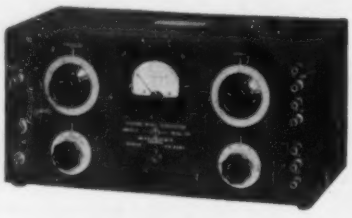

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BOONTON NEW JERSEY

November 4 at 7:30 p. m. in the Southern Alkali Conference Room. A short business meeting was held during which Nominating and Dance committees were appointed, and the undersigned appointed temporary press secretary. (The dance, an annual affair, is to be held during the month of December in addition to our regular December 2nd meeting.)

A motion was made and carried that all members paying their 1948 dues by February 1 receive an I.S.A. pin, to be purchased by the Section.

Mr. Carson then gave an interesting demonstration of electricity in action and forces of magnetic induction. He was followed by Homer Givens, Section Secretary, who gave a short report on the I.S.A. Conference and Exhibit in Chicago for the benefit of those members who were not present to hear the complete report at the October meeting.

After a short round table discussion, the meeting was adjourned.

On January 6, 1948, the South Texas Section, meeting jointly with the Chemical Society and the South Texas Engineers Club, will be addressed by a representative of Fischer & Porter Company on the subject of "Chlorinators and Their Control." The meeting is to be held at 7:30 p. m. in the C P & L Auditorium. —JIMMY OSWALT, *Press Sec'y.*

TENNESSEE

The Tennessee Section held its regular October meeting on Wednesday, October 29. Dinner was at the Sherwood at 7 p. m., preceding the meeting at the Civic Auditorium.

President F. H. Theile called the meeting to order and the Secretary read the minutes of the previous meeting. Mr. Robert Paris then gave a 20-minute paper on the subject of "Potentiometers," using slides and numerous sketches on the blackboard.

The guest speaker of the evening was Mr. F. R. Davis, Sr., of the Davis Emergency Equipment Company. The subject of Mr. Davis' talk was "Catalytic Combustion, Thermal Conductivity and Electrolytic Conduction." He used instruments to illustrate the features of his talk, and aroused much interest as evidenced by the discussion during and after the talk.

The meeting was adjourned at 10:15 p. m.
—L. W. THAYER, *Sec'y.*

TWIN CITIES

The Twin Cities Section held its monthly dinner meeting on October 27th in the new Coffman Memorial Union on the University of Minnesota campus.

The speaker of the evening was Mr. W. H. Steinkamp, Sales Manager of Brown Instrument Company, who talked on "Some Practical Aspects of Automatic Control." His talk was very well prepared and well illustrated, and as a result the meeting was very interesting.

The December meeting will be held the 16th, also at the Coffman Memorial Union, with dinner at 6:30 and the business meeting at 7:30 p. m. The speaker will be Dr. Gordon Volkenant, Associate Director of Research, Minneapolis-Honeywell Regulator Company, who will present "Electronics, Gadgets and Gimmicks."

On January 27th, Mr. F. R. Davis of the Davis Emergency Equipment Company will address the Twin Cities Section on "Gas Measuring and Analyzing Equipment." This meeting is also to be held at the Coffman Memorial Union at the University of Minnesota—dinner ($1.50) at 6:30 and the meeting at 7:30 p. m. —RAY HOPPER, *Corr.*

WAYNE COUNTY

The Wayne County Section met on October 20th at the Presbyterian Church Hall, Wyandotte, Michigan. An unusually fine dinner was followed by a short business meeting and the introduction of visitors and new members.

The speaker was Mr. Henry Stoll of the Taylor Instrument Companies, Rochester, New York. The subject of Mr. Stoll's talk was "The Orifice Flow Meter," and it was covered from fundamentals to installation and servicing. There were many useful notes and formulas which we eagerly put in our notebooks, and many questions were asked and capably answered. Everyone from novice to engineer enjoyed the talk.

Our November 17th meeting was something of a departure from routine. Following the dinner we had a brief business meeting and a discussion of our coming Christmas party, and a showing of the manufacture and application of Fulton Sylphon bellows.

Our speaker was Mr. Graebe of Imperial Oil, Sarnia, Ontario. He gave a talk on the organization of a large instrument department, elaborated on its position in the company, and described its scope of operations and the training of its members. This instrument department is headed by an instrument engineer and his assistant, and has five subdepartments, one of which is a well-equipped shop. It was helpful to all of us who are faced with problems of starting off a new department or enlarging or revamping an old one.

We are glad to note a sprinkling of I.S.A. pins and will be glad when all the members have them. —JOHN MACPHERSON, *Corr.*

Miscellaneous

LOST AND FOUND

Among the many activities of the Information Booth personnel during the Chicago Conference in September was the handling of a Lost and Found Bureau. While it must be admitted that many articles reported lost were never found, a goodly number of items *were* turned in and eventually reached their rightful owners. Two items, however, were found and turned in, but the owners have not as yet been located.

One of these is a soldering iron, which undoubtedly belongs to some member of the Chicago or Northern Indiana Sections or to one of the exhibitors. It is now in the possession of Hugh Ferguson, and may be claimed by contacting either Mr. Ferguson (Peoples Gas Light & Coke Co., 45 Pershing Road, Chicago) or the Editor of the Journal (R. R. Proctor, 2213 Ridge Ave., Evanston, Ill.)

The other item is a stenographic notebook containing copious notes on papers presented at the Conference, particularly those of the Radioactivity Session. There are no identifying marks or names except a terse statement concerning one paper and the note "Favison agrees with me." One sentence on another page indicates that the notebook belongs to someone from the east, reading as it does "Train, Eliz to upt N. Y. a/8—$0.60." The owner of this notebook may claim same by writing the Editor.

INSTRUMENTATION IN TURBINE TESTING

(*Concluded from Page 1112*)

tests were run at one load and the spindle position was changed for each test. This was done, primarily, to find out the effect of variations in spindle position on turbine efficiency. In the case of this discussion we can utilize these findings to show the consistency of test results. The first test was run with turbine clearances at minimum running position, the second with the spindle pushed "off" (increasing the clearances) 0.024", and the third with the clearances increased by 0.022" more. The results of the second test showed an increase in heat consumption of 1.97% over the first test, and the third an increase of 1.54% over the second. Expressing these results on an increase in heat consumption per UNIT of increased clearance basis, we find that the second test showed an increase of 0.82% for a change of ten thousandths of an inch and the third test an increase of 0.70% for the same unit of clearance change—which is to say, for the same unit change in clearance the deviation between tests was but 0.12%. Thus, it can be readily seen that reproducibility of results was excellent.

CONCLUSION

We feel that the purchase and installation of precision instruments, their proper and precise calibration, and their intelligent use, will secure results which are reproducible and accurate. The careful training and instruction of the test personnel, thorough planning of the test procedures, and arrangements and discussion with the operating force, all aid materially in the attainment of these accurate and consistent results.

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 1161.

O-564 **"Instrument News."** 4-page 8½" × 11" Vol. 3, No. 2 of this house organ contains articles on ground testing instruments, multi-range frequency meter, transformer turn ratio test set, rheostats, etc. James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

O-565 **Hydraulic Presses.** 2-page 8½" × 11" bulletin pictures and describes a 50-ton press for molding and laminating operations in plastic, wood or rubber; also a hand-operation hydraulic press. Laboratory Specialties, Inc., Wabash, Ind.

O-566 **Time-operation Recorder.** 4-page 8½" × 11" bulletin pictures and describes maker's "Electro-count" which records machine down time, accurate account, rate of production and date and time piece is made. Electronics Div., Lansing Engineering Co., 735 E. Kalamazoo St., Lansing 12, Mich.

O-567 **Bearing Race Tester.** 2-page 8½" × 11" data sheet illustrates and describes "Type WAA Race Tester" for measuring bearing race waviness and control of production set-ups. Physicists Research Co., Ann Arbor, Mich.

O-568 **Surface Roughness Measurer.** 6-page 8½" × 11" folder illustrates and explains the "Profilometer" a direct-reading instrument for measuring surface roughness in definite inch units. Physicists Research Co., Ann Arbor, Mich.

O-569 **"How to Select Binoculars."** 24-page 9" × 6" booklet presents a history of binoculars, facts about specific types and special pointers on selection. Sard Binoculars, Kollsman Instrument Div. of Square D Co., Elmhurst, N. Y.

O-570 **Quality Control.** 4-page 8½" × 11" folder entitled "Inspecting Incoming Material" suggests procedures that may be followed from time material arrives in plant until it is accepted or rejected. Standard forms illustrated. North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.

O-571 **Conductivity Cell Installation.** 2-page 8½" × 11" Instruction Section C-1 gives information on the illustration and maintenance of conductivity cells. Industrial Instruments, Inc., 17 Pollack Ave., Jersey City, N. J.

O-572 **"Electronic-Pneumatic-Electrical Instrumentation."** 32-page 8¾" × 11¾" Vol. 3, No. 1 issue of this house organ features several articles: "Quality Control at Servel, Inc.", "Measuring and Recording Dewpoint Temperatures of Industrial Gases", etc. The Brown Instrument Co., Wayne and Roberts Aves., Phila. 44, Pa.

O-573 **"Ceneo News Chats."** 24-page 7¾" × 10¾" No. 57 of this house organ contains articles covering thermal recorder, cathode ray oscilloscope, immersion heaters, polariscope and other scientific apparatus. Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

O-574 **Control Valves.** 36-page 8½" × 11" Bulletin 277-2 gives complete information on maker's line of "Stabilflow" control valves, needle type, butterfly and special valves, lubricator bonnets, "Vernier Valvactor," etc. Specifications charts, diagrams included. The Foxboro Co., Foxboro, Mass.

O-575 **Industrial Limit Unit Switch.** 2-page 8½" × 11" Data Sheet No. 42 pictures and describes the "LMR 5 Housing" for providing rotary actuation for the "Pin" plunger basic switch. Micro Switch, Freeport, Ill.

O-576 **Dilatation Interferometer.** 8-page 8½" × 11" Bulletin 140-74 describes and illustrates a complete assembly for measuring the coefficient of thermal expansion of small specimens by the interferometer principle, for temperatures up to 1000°C. The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

O-577 **X-ray Diffraction.** 4-page 7¾" × 10½" folder shows construction and explains application of "X-ray Diffraction Camera for Microtechniques." Illustrations: sample diffraction patterns shown for stretched and unstretched polyethylene. North American Philips Co., Inc., 100 E. 42nd St., N. Y. 17, N. Y.

O-578 **p-H Electrodes and Accessories.** 12-page 8½" × 11" Bulletin 8 6-C pictures and describes maker's line of pH meters, accessories, electrodes, indicators,, and the "Beckman" spectrophotometer. National Technical Laboratories, S. Pasadena, Calif.

O-579 **Photographic Equipment.** 64-page 7⅛" × 12" Catalog No. 947 C is a fully-illustrated fiftieth anniversary catalog about "everything photographic." cameras, enlargers, accessories, etc. Burke & James, Inc., 321 S. Wabash Ave., Chicago 4, Ill.

O-580 **Carbon and Sulphur Analysis.** 12-page 8½" × 11" folder describes maker's complete line of carbon and sulphur determination equipment for organic and inorganic materials. Complete with illustrations. Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.

O-581 **Pressure Gages.** 4-page 8½" × 11" bulletin pictures and describes heavy-duty type standard gages (pressure, vacuum, compound, altitude, hydraulic and drawn case gages, with instructions on how to order and price lists. H. O. Trerice Co., 1420 W. Lafayette Blvd., Detroit, Mich.

O-582 **Physical Testers.** 4-page 8½" × 11" engineering catalog with price data on precision laboratory and production line test equipment, such as multi-low-range testers, "Model K" for tensile, transverse, compression and shear testing, etc. W. C. Dillon Co., Inc., 5410 W. Harrison St. Chicago 44, Ill.

O-583 **Remote-positioning Servo Control.** 4-page 8½" × 11" bulletin gives complete information on "Synchro-link," packaged remote control for positioning a distant motor according to the setting of a control transmitter. Yardeny Laboratories, Inc., 105 Chambers St., New York 7, N. Y.

O-584 **Load Weighing Instrument.** 4-page 8½" × 11" Bulletin 264 describes and illustrates maker's "Air Cell" made to insert in the grip slot of a testing machine, available in several models providing capacities as low as 30 to 1,200 lbs. The Baldwin Locomotive Works, Phila. 42, Pa.

O-585 **pH Measurement.** 12-page 8½" × 11" technical bulletin presents in non-technical terms a definition of pH, dis-

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Unmounted Cells

The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

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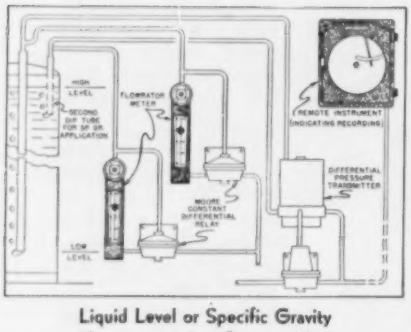
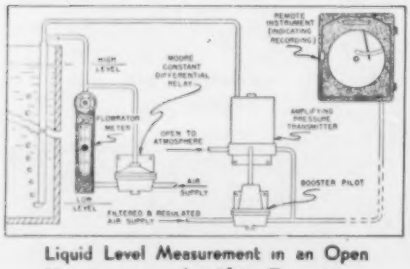
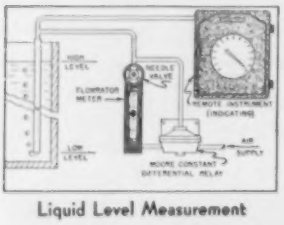


Liquid Level or Specific Gravity Measurement in a Pressure Tank



Liquid Level Measurement in an Open Vessel, using an Amplifying Transmitter



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cussion of its importance to industry and how pH measurements are made. Various commercial pH meters for laboratory use are pictured and explained. Fisher Scientific Co., Eimer and Amend, 635 Greenwich St., New York, N. Y.

O-586 **Metal Tubing Circuits.** 76-page 5½" × 7¾" Handbook No. 111, "Tube Fitters' Manual," illustrates, charts and gives complete information on selection, sizing, layout and installation of metal tubing circuits for leakproof systems. The Parker Appliance Co., 17325 Euclid Ave., Cleveland, O.

O-587 **Electrical Instruments.** 92-page 9" × 11¼" catalog is divided into sections, each indicated by a tabbed divider sheet (Panel, Switchboard, Portable, etc.) Pictorial content and description head each section, followed by catalogued listing and technical data. Roller-Smith, Bethlehem, Pa.

O-588 **Radioactivity Count Rate Meter.** 2-page 8½" × 11" data sheet pictures and describes "Model 2610" portable count rate meter designed for general survey work and for location of small amounts of radioactive materials. Instrument Development Laboratories, Chicago, Ill.

O-589 **Safety Devices for Steam and Hot Water Boilers.** 4-page 8½" × 11" bulletin C-35 briefly catalogs maker's feeders, feeder cut-off combinations, low-water fuel cut-offs, safety relief valves, etc. McDonnell & Miller,, Inc., Wrigley Bldg., Chicago 11, Ill.

O-590 **"The Toolmaker's Microscope."** 2-page 8¼" × 11⅛" reprint of article by Karl F. Kirchofer points out various ways in which the toolmaker's microscope may be used throughout the shop and in inspection. Illustrations showing actual use. George Scherr Co., 200 Lafayette St., New York 12, N. Y.

O-591 **Motor-operated Stiffness Tester.** 4-page 8½" × 11" Bulletin No. 1430 illustrates how stiffness tester can be applied in testing paper, textiles, leather, plastics, metal foil and finishings; its range and capacity and the standard size samples uses. W. & L. E. Gurley, Troy, N. Y.

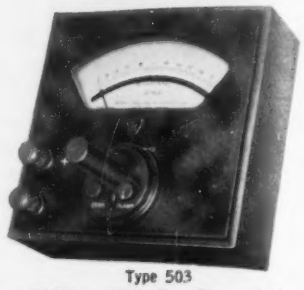
O-592 **"The Experimenter."** 8-page 6" × 9" Vol. XXII, No. 4 issue of this house organ features news on electrical measurements and their industrial applications under titles: "Dr. Beranek Becomes General Radio Consultant on Acoustics," "A Frequency Monitor for Television Video Transmitters and other A-M Service," "Frequency Loudness Chart for Industrial Noise." General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

O-593 **Electric Timers.** 4-page 8½" × 11" bulletin pictures and describes maker's line of timers, relays, meters, giving functions, model numbers and uses. R. W. Cramer Co., Inc., Centerbrook, Conn.

O-594 **"The Capacitor."** 16-page 5½" × 7¾" Vol 12, No. 9 issue of this house organ features: "Phase Inverter Circuits," with diagrams, and "The Radio

Instrument Mechanic: To maintain process control, flow meters, pressure gauges, recording potentiometers, PH instruments in a paper mill. Location Western Maryland. Box 141 Instruments Publishing Co., 1117 Wolfendale Street, Pittsburgh 12, Pa.

RAWSON
SEMI-SUSPENDED
METERS



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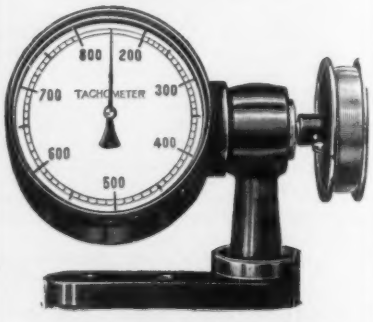

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O-595 **Rack and Panel Type Connectors.** 24-page 8½" × 10½" Bulletin No. 47-547 gives application photographs, sketches, tabular data, insert arrangements, etc., for rack and panel equipment. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.

O-596 **"Faxfilm Fax."** 4-page 8½" × 11" Vol. II, No. 1 issue of this house organ contains data on ball bearing races, lubricants labs, projecting profiles of surfaces and information and illustrations on maker's projection units, comparators, etc. The Faxfilm Co., 1220 W. Sixth St., Cleveland 13, Ohio.

O-597 **Impact Test Machine.** 4-page 8½" × 11" Bulletin 253 describes and illustrates two "Sonntag" universal impact machines of the pendulum type for making Charpy, Izod and tension tests in plastics and metals. The Baldwin Locomotive Works, Testing Equipment Dept., Philadelphia 42, Pa.

O-598 **"The Ohmite News."** 2-page 8½" × 11" issue of this house organ has articles on ½- and 1-watt "Little Devils"; new model train control rheostat; calculation of tapped resistor for typical voltage divider circuit and other products. Ohmite Manufacturing Co., 4835-41 Flournoy St., Chicago 44, Ill.

O-599 **Recorder-controller.** 16-page 8½" × 11" Educational Bulletin No. 7 pictures and describes maker's "Capacitrol" strip-chart recorder. Electronic circuit and recording system are treated individually; a section gives instrument specification and mounting dimensions. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

O-600 **Electric Utility Laboratory Ovens.** 4-page 8½" × 11" bulletin pictures and describes maker's new Laboratory equipment with "Trigger Thermo" control. Lists construction, insulation, heat control and heating element of utility lab ovens. Modern Electric Laboratory, 6131-6133 S. Wentworth Ave., Chicago, Ill.

O-601 **Mercury Contact Relays.** 12-page 8½" × 11" catalog presents description, definitions, charts of operating characteristics and dynamic characteristics of maker's glass sealed relays. Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y.

O-602 **Turbidity Recorder.** 2-page 8½" × 11" bulletin 604 pictures and describes maker's "TR 6" instrument, a continuous potentiometer recorder. Sketches for various forms of sampling chambers, indicators and recorders. Ess Instrument Co., Bergenfield, N. J.

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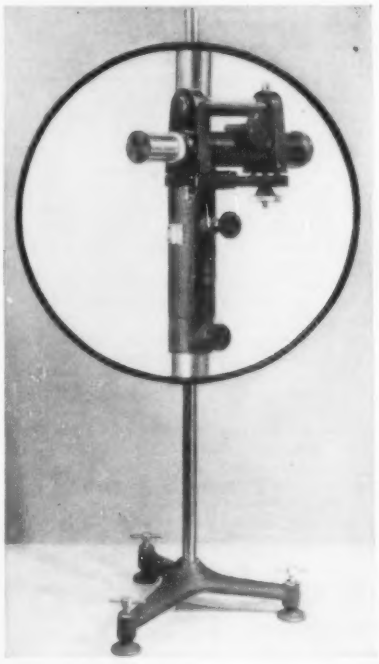
O-603 **Indoor and Outdoor Thermometer.** 6-page 3¼" × 6¼" leaflet describes "Duo-Temp" square-case thermometer with two scales on dial: one for indoor; the other for outdoor (flexible capillary). Jas. P. Marsh Corp., 2073 Southport Ave., Chicago 14, Ill.

O-604 **Pressure Switch.** 4-page 8½" × 11" bulletin presents applications, engineering data summary sheet and check table for "Model 310" pressure switch for

Gaertner

M909-M910 CATHETOMETERS



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system pressures from 400 to 3000 lbs./in.². Meletron Corp., 950 N. Highland Ave. Los Angeles 38, Calif.

O-605 **Single-drum Kymograph.** 2-page 8½" × 11" Bulletin No. 477-1 pictures and describes "Mono-Drum Chart Mover," giving range and flexibility features. Correll & Correll, Haworth, N. J.

O-606 **Hydrostatic Test Unit.** 6-page 8½" × 11" bulletin pictures and describes "Twin Seal" check valves and test unit. Includes price schedule. Mansfield & Green, 4601 Euclid Ave., Cleveland 3, Ohio.

O-607 **Float Switches.** 2-page 8½" × 11" Bulletin L3 covers the first two items in maker's "Type L" series, "L200," two-pole, double break, snap-action float switch and "LP200," a complete switch ready to install. Automatic Control Co., 1005 University Ave., St. Paul 4, Minn.

O-608 **Precision Optical and Linear Measuring Instruments.** 10-page 3¾" × 8½" bulletin illustrates and lists all maker's products, arranged according to the basic function for which they are intended, such as linear measurements, coödinate, angular, spectral, polarized light measurments, etc. The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.

O-609 **Abrasion-testing Instrument.** 32-page 5½" × 8½" instruction manual for the "Taber" abraser, an instrument for measuring rate of wear of surface finishes subjected to rubbing abrasion. Taber Instrument Corp., North Tonawanda, N. Y.

O-610 **Electrical Indicating Instruments.** 4-page 8½" × 11" bulletin pictures and describes maker's panel instruments, direction indicator, etc., with accuracy within 1½%. Price schedule on back page. Shelby Instrument Co., 321 W. 7th St., Long Beach 13, Calif.

O-611 **"Announcer of Scientific Equipment."** 16-page 8¾" × 7½" No. 47-10-28 issue of this house organ features the article: "Functional Design of Laboratory Glassware," plus illustrated description covering recent developments of apparatus and supplies. Eberbach & Son Co., Ann Arbor, Mich.

O-612 **"The Motorgram."** 4-page 8½" × 11" Vol. 27, No. 5 issue of this house organ presents information on maker's motors, in articles on "Cenca Hangosky Electropolisher," etc. Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

O-613 **Precision Weighers.** 4-page 8½" × 11" Bulletin No. 3201 pictures and describes six "Shadograph" scales for fine industrial weighing; lists specifications. The Exact Weight Scale Co., Columbus 12, Ohio.

O-614 **Vacuum Measurement.** 18-page 8½" × 11" booklet describes "Skanascope" principle in vacuum dehydration, de-airing and molecular distillation. Illustrations and description of vacuum monitor, dual vacuum monitor, "SMCI Skanascope." Skaneateles Mfg. Co., Inc. 122 Dickerson St., Syracuse 2, N. Y.

O-615 **Filling Machine.** 4-page 8½" × 11" bulletin illustrates and explains maker's filling machine, an automatic aseptic pipetting instrument with capacity from 5cc. to 100cc. or over. G. M. Manufacturing Co., 50 W. 3rd St., New York 12, N. Y.

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Supplement to **Instruments** *January 1947*

Open Letter from a Publisher to the Workers in his Field

Pittsburgh, Jan. 6, 1947

To my Fellow Workers in the Instrument Industry

I hope you will permit me to call you--the makers and users of instruments--fellow workers. I do not make or use instruments now--I am the publisher of Instruments, the Magazine of Measurement and Control. After my service in World War I, I worked for a while as an instrument user and subsequently with an instrument company. Over twenty years ago I decided that our Country had need for a publication with an editorial policy which advocated the greater use of instruments. For twenty years I have tried to faithfully serve you.

1929 A year after Instruments* magazine started, in 1929, we as an industry were faced with a similar condition as we are right now. At that time open hearings of the Ways and Means Committee were being held on the Tariff. Two foreign (German) manufacturers appealed to the users of instruments in advertisements in a scientific magazine, asking scientists to urge a return of duty-free importation of instruments and scientific apparatus. In these advertisements the names of British instrument firms were also mentioned. At that time instruments were classified in the British tariff as "Key Industry Goods" and carried a 33 1/3% to 50% duty.

1947 On January 13, 1947 the U. S. State Department will start hearings on new reciprocal trade agreements. Products made and used by you in your daily work have been included by the Committee on Reciprocity Information for negotiations in the proposed Trade Agreements between our country and the following:

Australia, Belgium, Brazil, Canada, Chile, China, Cuba, Czechoslovakia, France, India, Lebanon, Luxembourg, Netherlands, New Zealand, Norway, Union of South Africa, Union of Soviet Socialist Republics, United Kingdom.

International theorists are pledged to reduce all international trade barriers including our own. They tell us that we are going to export more and to accomplish this we must import more. I cannot go along with this theory as I fail to see how this can be done unless American wage rates are reduced and, of course, unless our standard of living is lowered.

Read the following carefully. If you are convinced that the reciprocal trade treaties being considered will endanger the future defense of our country, the future growth of the industry in which you and I work, and the future of your family and yourself, write or wire your senators and representatives.

New Deal Politicians, preaching free trade, believe you and I are stupid. After you have taken the time to consider the following data, I am sure you will realize that we can only continue in our jobs if the duty on instruments covers the difference in the wages received by you and the amount received by foreign workers. I am certain that you appreciate that spending on the American basis is consistent with the privilege of earning on the American basis.

Here is a table showing the hourly wages paid skilled instrument makers in the United States with that paid skilled workers in other countries:

Wage Rates for 1946 for Skilled Male Workers in Various Countries

Country	Hourly Wage in dollars	Exchange Rate	Authority
United States	2.33		Industry Survey Dec. 1946
Canada	0.70		Labor Dept. Sept. 1946
Switzerland	0.65	1 franc=23.36¢	Labor Dept. Oct. 1945
Britain	0.56	1 shilling=20.18¢	Labor Dept. Jan. 1946
Sweden	0.55	1 crown=27.81¢	Labor Dept. Feb. 1946
France	0.46	1 franc=0.84¢	Labor Dept. July 1946

Methods of instrument production in our Country do not differ greatly from those abroad as the total demand does not permit the use of the mass production methods of other American industries. Large-scale production machinery is not applicable since the nature of the products require chiefly skilled manual operations. These operations do not vary greatly in other countries as the skilled hands of the foreign instrument worker are of the same efficiency as ours. Where machine operations are performed by skilled workers, foreign manufacturers are as well versed in efficiency as we are. The best example of this is in the manufacture of jewel bearings. There are no methods in the instrument industry whereby capital invested in equipment and plant can secure lower unit cost of production than can be had abroad. Tariff considerations must weigh the wages and hours of work here and abroad.

The instrument industry uses a low percentage of materials

During the war Switzerland sent to the United States millions of watches

Year	Number	Value
1941	4,300,513	$13,778,248
1942	5,292,712	$19,211,681
1943	7,996,589	$34,984,113
1944	6,912,332	$37,200,843
1945	9,398,716	$47,456,293

During this time, American watch manufacturers were busy manufacturing precision instruments vital to victory in World War II. During this time the prices charged by American industries were controlled by OPA but the OPA presented no problem to the Swiss watch industry as the above figures show that the average price of imported watches rose 68%. Therefore, even in peacetime, you and I would be at the mercy of the Swiss for our supply of watches.

During the years 1941-1945, no military timing devices reached our Armed Services from Switzerland. But Switzerland did supply such devices to our enemies. What would we have done without our American Watch Industry?

During World War I, Switzerland could not furnish us with all the jewel bearings for instruments and timing devices required by our Armed Forces. A jewel bearing industry was developed in the United States to fill the needs at that time, but this industry eventually lost out because the Swiss underaold us as our jewel bearing industry was not protected against the lower labor costs.

In World War II, Switzerland again could not furnish us with the necessary jewel bearings. Again we invested millions of dollars to create a jewel bearing industry. In the 1944 issues of The Instrument Maker, I warned against our again making the same mistake we made after World War I. But the minute jewel bearings could again be imported from Switzerland, after the defeat of Germany, Government claimant agencies proceeded to meet jewel bearing requirements with foreign products.

The latest information I have is that no jewel bearings are being made in the United States today. When a mistake is made once it can be forgiven, but if the same mistake is made the second time it can only be considered damn foolishness. It certainly looks like our State Department wants to carry the same foolishness over to the manufacture of instruments. Russia and England are both creating a jewel bearing industry. They do not intend to depend on imports. Russia and England are also carving out their spheres of influence in Europe which may cut off the Swiss supplies again and soon. The jewel bearing industry will again be essential if we are attacked.

Great Britain has recognized the importance of the instrument industry in the adoption of definite policies for its protection. Britain's instrument experience in World War I brought about the enactment of the "Safe Guarding of Industries Act," which designates certain "Key Industries." The Act requires that all requests for importation of "Key Industry" items be submitted to the Board of Trade in order to secure permission for the entry of the designated item. This board then canvasses the domestic British manufacturers to ascertain if similar items are produced in Britain. If not, some domestic British manufacturer is asked to manufacture the same from submitted blue-prints and specifications. This act is more effective than any tariff rate; however, it is supplemented by tariff rates in the highest brackets, as follows:

33 1/3% on scientific instruments
50% on optical instruments and optical glass

Late reports indicate that the British instrument industry is expanding through Government aid, by the following methods:

1. Safeguarding of Industries Act
2. The highest tariff rate
3. Preference tariff with her Dominions

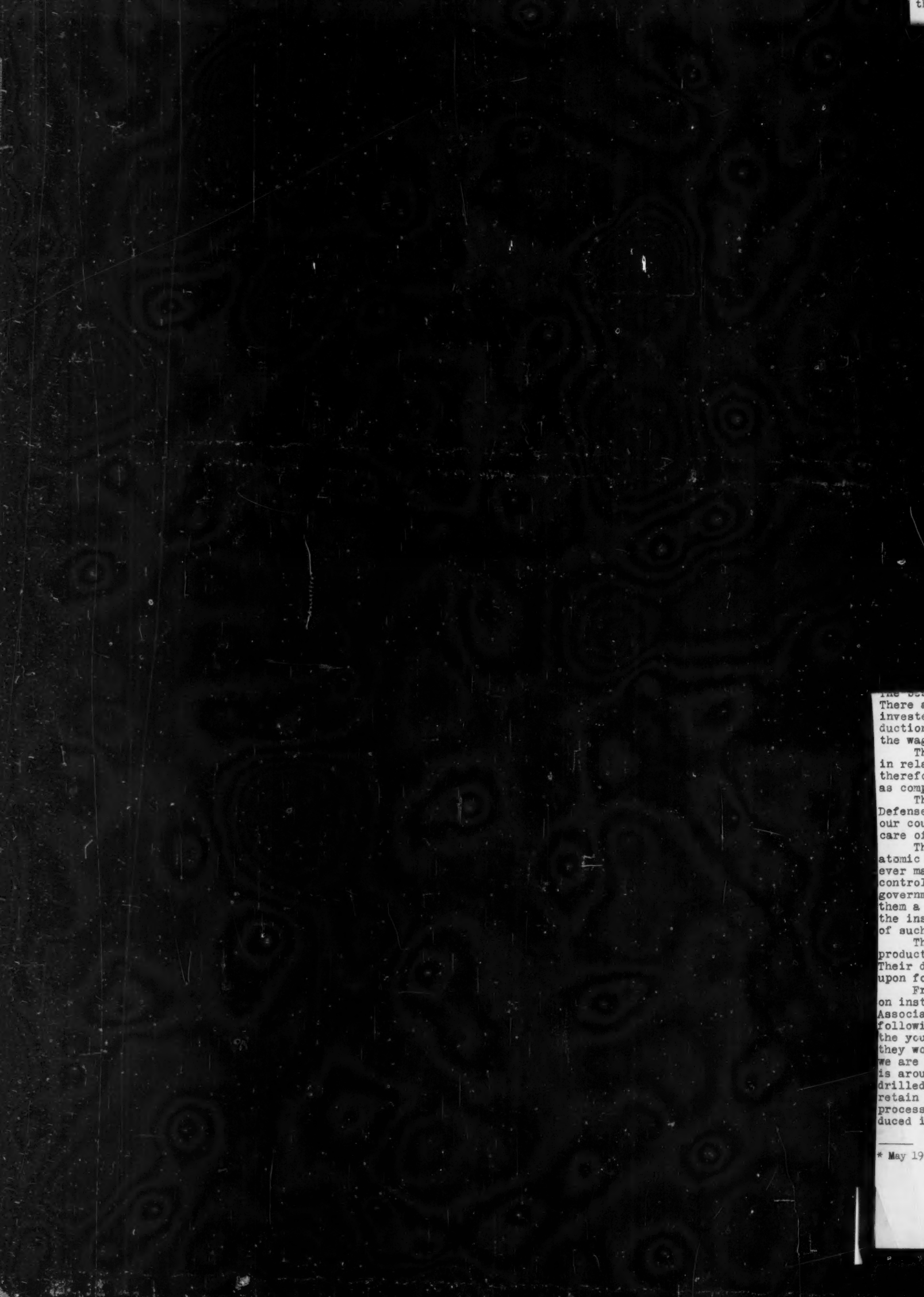
The British Instrument Industry is making every effort to capture the instrument business of the world. An exhibit consisting entirely of British instruments was arranged by the British Instrument Industry for Stockholm in 1946, and a similar exhibit is being planned for 1947.

The British Instrument Industry has made representations to the British Government for the reimposition of the Key Industries Duties and these representations were so far successful that the duties have been re-imposed. The protection of the British Industry figures largely in the discussions on the German Instrument Industry.

Russia has a fixed policy to be independent of all other nations by establishing an instrument and jewel bearing industry within her own borders. The German Zeiss plant is under Russian control and products produced are being offered for sale in Switzerland.

France is known for its production of optical instruments, optical glass and electrical measuring instruments.

Czechoslovakia has been favorably known for the production



The instrument industry uses a low percentage of materials

optical glass and electrical measuring instruments.

Czechoslovakia has been favorably known for the production

The best example of this is in the manufacture of [illegible]. There are no methods in the instrument industry whereby capital invested in equipment and plant can secure lower unit cost of production than can be had abroad. Tariff considerations must weigh the wages and hours of work here and abroad.

The instrument industry uses a low percentage of materials in relation to man-hours--70% labor to 30% materials. Labor is therefore an unusually high cost-factor in instrument manufacture as compared with mass production items.

The American instrument industry is essential for National Defense, as was proved after Pearl Harbor, when only the fact that our country had an instrument industry made it possible to take care of the tremendous instrument requirements of our Armed Forces.

The importance of instrumentation in the production of the atomic bomb is known by all of you. There isn't a single product ever made that required as many different types of instruments and controls to control it as the atomic bomb. We could give any other government the formula for making atomic bombs and it wouldn't do them a bit of good for the simple reason that no other country has the instrument industry necessary for the successful manufacture of such bombs.

The training programs of the Armed Forces also required the production of an unusual number of instruments in a short time. Their delivery would not have been possible had we been dependent upon foreign instruments.

From a psychological viewpoint, Americans should be trained on instruments produced in America. Dr. Thomas B. Freas, former Associate Professor of Chemistry at Columbia University, made the following statement: "It undoubtedly does have a bad effect upon the young men of the colleges to see much of the things with which they work come from foreign countries. It produces a feeling that we are unable mentally to cope with other people and the feeling is aroused that the foreigner is in some way superior. This is drilled unconsciously into the minds of the young men and they retain this impression to some extent all of their lives. As a process of Americanization, I think the apparatus should be produced in this country."

---

* May 1929 issue contained an article "The Proposed Tariff and Instruments"

within her own borders. [illegible] German Zeiss plant is under Russian control and products produced are being offered for sale in Switzerland.

France is known for its production of optical instruments, optical glass and electrical measuring instruments.

Czechoslovakia has been favorably known for the production of scientific glassware and optical instruments. She expects to increase present production.

Holland prior to World War II exported scientific instruments including precision balances and weights, electrical and optical instruments.

Belgium is reported to be producing optical glass.

Switzerland is noted for the exportation of watches, jewel bearings, precision instruments, spectroscopes, toolmakers' microscopes, surveying and engineering instruments and aerial mapping equipment. According to reports none of her factories was destroyed during the war.

Italy realized the importance of the instrument industry by combining the most important firms under a Government trust. During the war this firm had 5,000 workers; at present 2,000 men are producing microscopes and telescopes.

Germany. The latest reports indicate that the Allied Control Commission will permit reestablishment of the instrument industry. At present the exporting of instruments is under regulations but no doubt exports will be expanded.

I am for America...I am for the protection of the American Instrument Workers in their jobs...I am for a bigger and better instrument industry to produce the tools for measurement and control which make possible a higher standard of living at lower cost.

I believe we should only impose no import duties on the products from those countries whose wage and living standards are equal to our own.

I am for the protection of the American Instrument Industry as it is recognized and protected by adequate tariff rates in other nations as a key industry essential to national defense, public health and production control. Should not our Nation give it the same recognition?

Richard Rimbach

Publisher of Instruments
and of The Instrument Maker

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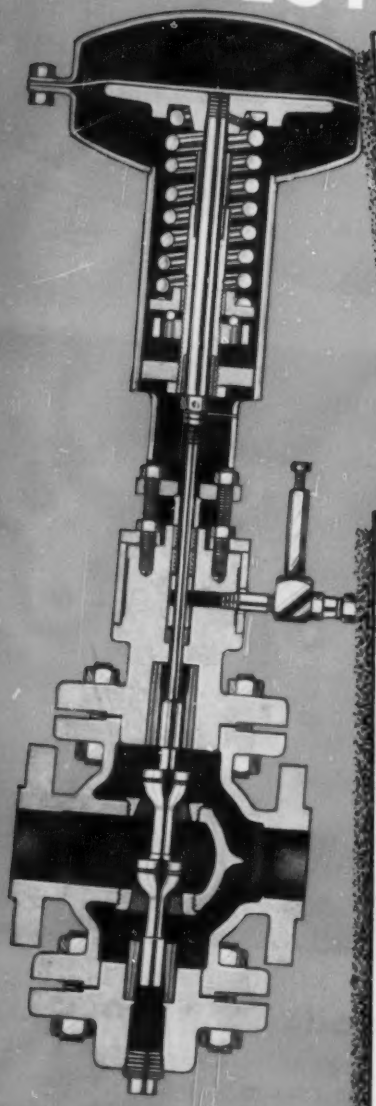

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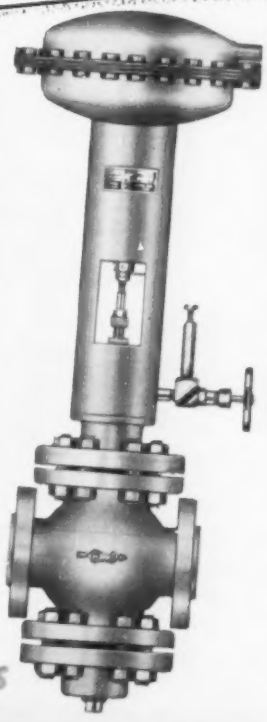

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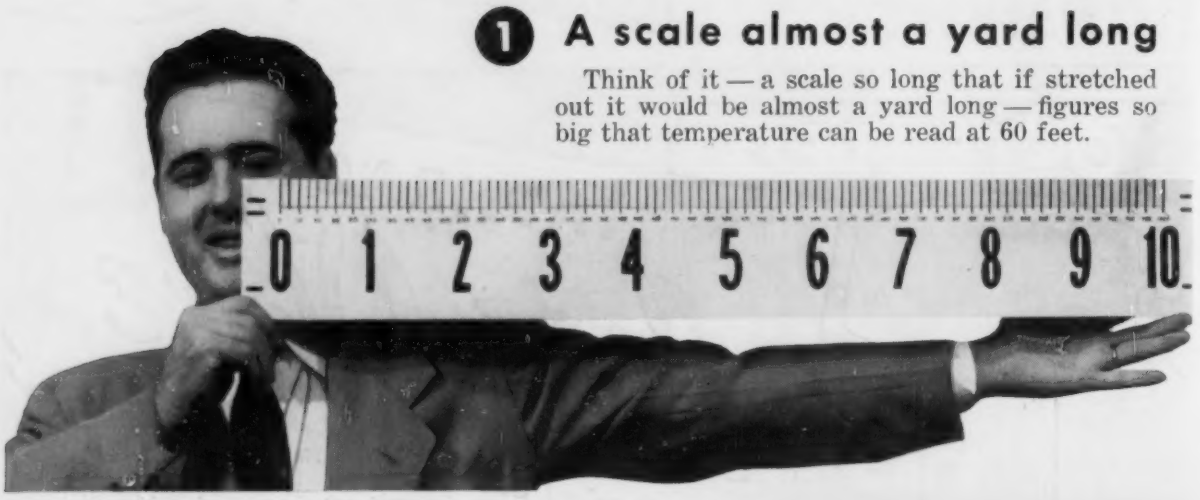
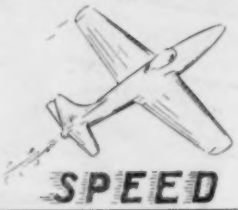


2 ElectroniK performance



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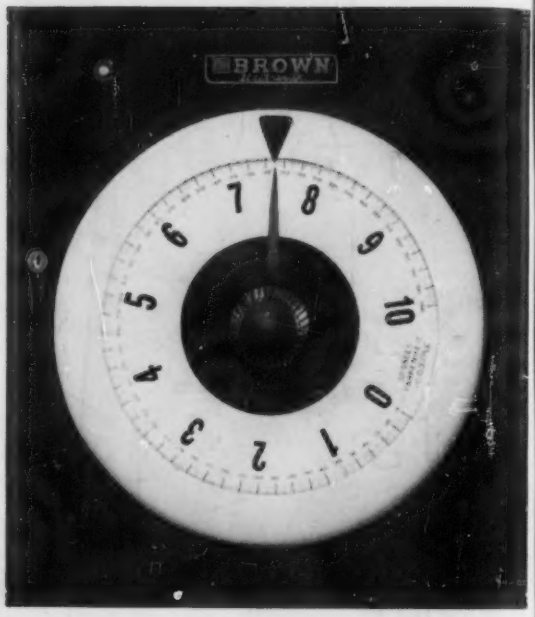

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